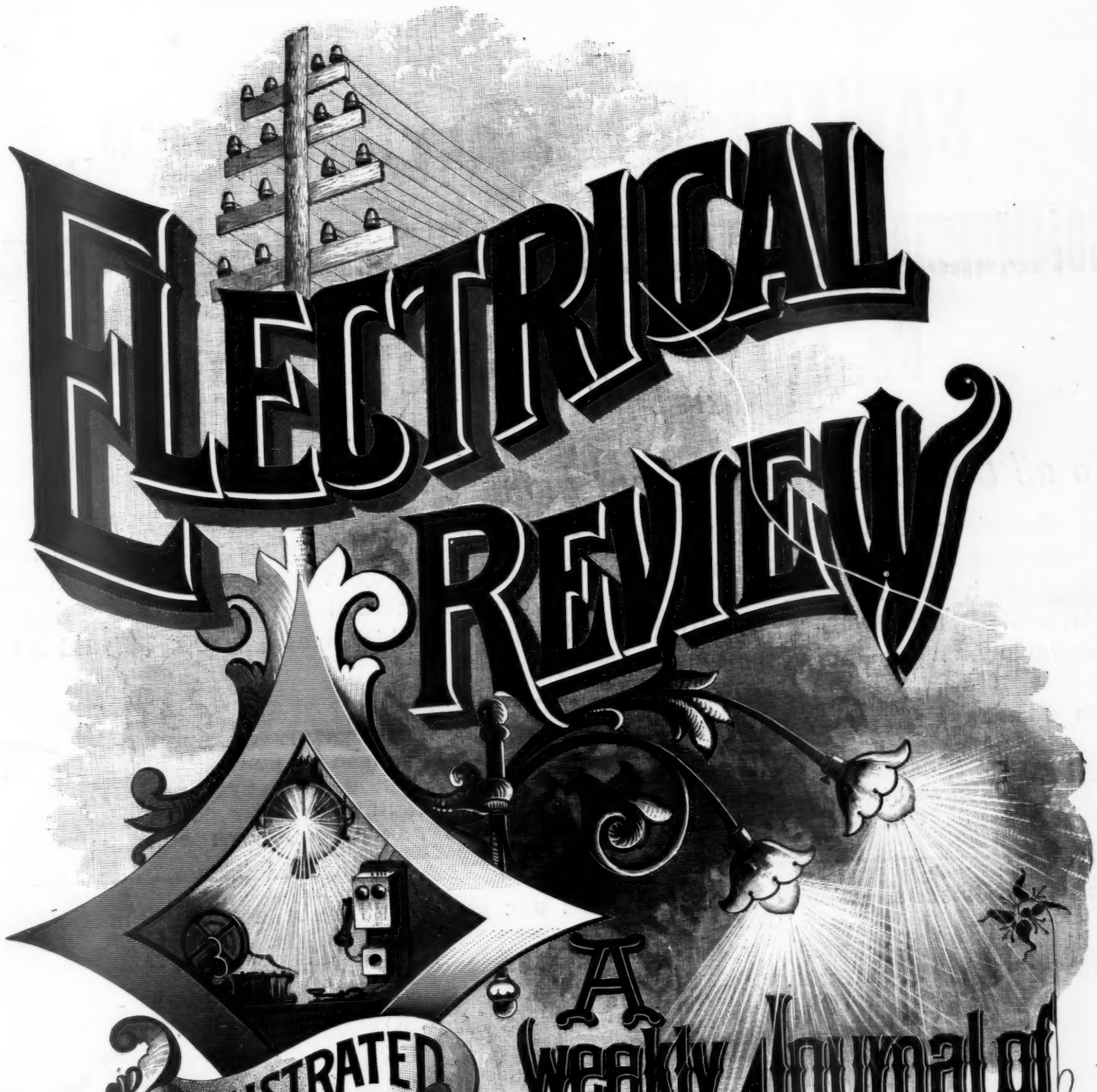


ILLUSTRATED A Weekly Journal of ELECTRIC LIGHT AND POWER, TELEGRAPH, TELEPHONE & SCIENTIFIC PROGRESS.

Vol. 13, No. 3.
September 15, 1888.

NEW YORK, U.S.A.

$3.00 Per Annum.
Single Copies, 10 Cts.

SAWYER-MAN ELECTRIC CO.,

COMMERCIAL AGENT OF THE CONSOLIDATED ELECTRIC LIGHT CO.

No. 510 West 23d Street, New York,

August 1st, 1888.

To all Users of Incandescent Lamps:

Experience has demonstrated that the life and utility of the Incandescent Electric Lamp is increased and the cost of its manufacture diminished by a decrease of the electromotive force. We have, therefore, decided to divide our commercial lamps into three classes, viz: HIGH, MEDIUM, AND LOW VOLTAGE LAMPS; of which classes, 100, 75, and 50 volts, respectively, shall stand as the types.

THIS COMPANY, THE FIRST TO GIVE TO THE CONSUMER THE BENEFIT OF SUCH CLASSIFICATION, IS ENABLED, BY REASON OF INCREASED MANUFACTURING FACILITIES, AFFORDED BY THE ENLARGEMENT OF OUR NEW YORK AND PITTSBURGH FACTORIES, AND BY REASON OF VALUABLE IMPROVEMENTS MADE IN THE LAMP, TO OFFER THE FOLLOWING REDUCTION IN PRICES FOR LAMPS WITH OUR

STANDARD BASES

SUBJECT TO DISCOUNTS FOR CENTRAL STATION USE AND TO PURCHASERS OF ORIGINAL PACKAGES OF 250 EACH.

C. P.	50 Volt.	75 Volt.	100 Volt.
16, and under,	$0.70	$0.75	$0.80
20,	.75	.80	.85
24,	.80	.85	.90
32,	.90	.95	1.00

THREE CENTS WILL BE PAID FOR THE RETURN OF EVERY LAMP BASE WITH THE PLATINUM WIRE INTACT, DELIVERED IN GOOD ORDER AT EITHER OF OUR FACTORIES.

For the purpose of obtaining uniformity of production, and of reducing the cost of manufacture, we offer to purchasers of our lamps our Standard Sockets, without charge, in exchange for any other socket in use by them.

CORRESPONDENCE SOLICITED.

SAWYER-MAN ELECTRIC COMPANY.

ELECTRICAL REVIEW

ILLUSTRATED.

A WEEKLY JOURNAL OF

Electric Light, Power, Telephone, Telegraph and Scientific Progress.

VOL. 13, No. 3. WEEKLY. | NEW YORK, SATURDAY, SEPTEMBER 15, 1888. | $3 per annum. Single Copies, 10 Cents.

Copyright, 1888, by ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York.

Entered at Post Office, New York, as Mail Matter of the Second Class.

Lombardy Poplars as Lightning-Rods.

Professor Asa Gray observed that the reason which lies at the bottom of the general belief on the continent of Europe that lightning strikes the Lombardy poplar trees in preference to others is coming to light. Green herbage and green wood—sappy wood—are excellent conductors of electricity. A tree is shattered by lightning only when the discharge reaches the naked trunk or naked branches, which are poorer conductors. An old-fashioned Lombardy poplar, by its height, by its complete covering of twigs and small branches, and their foliage down almost to the ground, and by its sappy wood, makes a capital lightning-rod and a cheap one. Happily no one can patent it and bring it round in a wagon and insist upon trying it. To make it surer the tree should stand in moist ground or near water, for wet ground is a good conductor and dry soil a poor one. It is recommended to plant a Lombardy poplar near the house and another close to the barn. If the ground is dry the nearer the well the better, except for the nuisance of the roots that will get into it.

Jointing Phosphor-Bronze Wires Without Heat.

The following abstract from the *Electrotechnische Zeitschrift*, part 4, 1888, is given in the *Journal* of the Society of Telegraph Engineers and Electricians, upon a method for jointing phosphor-brŏnze wires without any application of heat: "It is very desirable to avoid by all means the heating of phosphor-bronze wires, as this leads to a decrease of the breaking strain, and consequently some means of jointing had to be sought for which might replace the method of soldering used for iron wires. Moreover, experience has shown that some local action is set up between the tin solder and the iron wires, which in time leads to a weakening of the joint; such action would of course be still greater with phosphor-bronze wires, owing to the greater affinity of tin and copper. The best substitute for solder is a copper amalgam, prepared as follows: Freshly precipitated copper oxide is heated in a tube in a stream of hydrogen until it is reduced to metallic copper. When thoroughly cooled, this fine copper powder is moistened with dilute sulphuric acid and well mixed with mercury, and is then washed. A simpler plan, though not such a good one, is to obtain the copper powder by reducing copper sulphate by means of metallic zinc. In making use of this amalgam for jointing wires, it is pressed closely round them and allowed to set. On this account a twisted joint is not very well adapted; a Brittania joint is better, as the amalgam penetrates inside the binding wire. But the best joint is made with a tube connection, the two ends of the wires being turned up at not too sharp an angle, and secured with binding wire; the amalgam is then pressed well into the tube, where it sets quite hard."

Must an Invention be Reduced to Practice Before Application for Patent.

That some such general rule would be a good one seems to us probable, but the converse has obtained till now. The point will hereafter be considerably discussed in view of the recent decision of the Commissioner of Patents in the matter of Prof. Arthur de Bausset's application for patent for an air ship. In that decision the following language is reported to have been used:

"Even if novelty were admitted, it must be held that a patent must be refused, at least until the applicant practically demonstrates the operativeness of his device. The patent system was never designed to protect the chimerical schemes of visionaries. Invention consists in more than the work of the imagination. This applicant has only carried his conception up to the point where invention must begin."

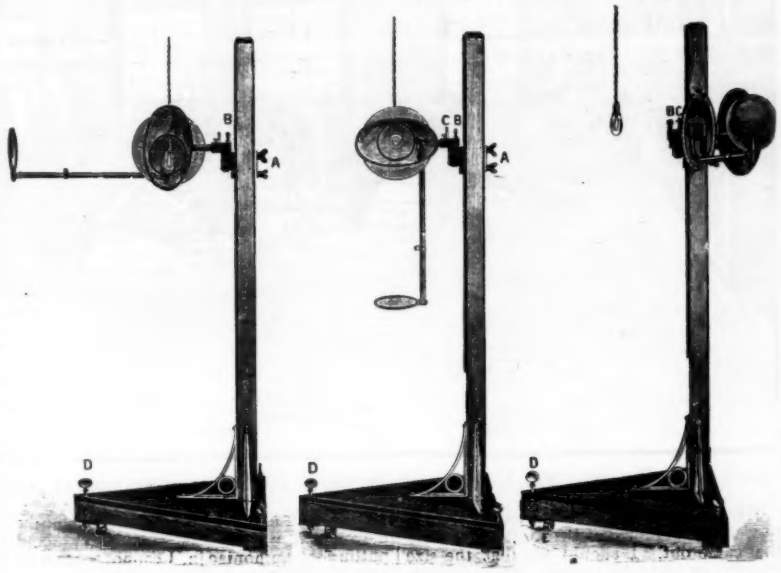
While this decision marks a radically new departure in the method of dealing with applications, we now incline to the opinion that it tends in the right direction. In this very line we are informed that an elaborate system of ventilation was patented several years ago and offered to the House Committee on Ventilation, in competition with others, which system never had any being beyond the drawing and specification in the patent. It is also to be noted that the so called inventor was neither an architect, a scientific man, nor one who had any practical experience in matters relating to ventilation. We doubt not that many of the fire escape, safety railroad car stove, automatic house flooding devices for protection in case of fire, etc., etc., patents never had any foundation in a practical device.

Now the trouble with all such patents is, that each may have a representation, in some crude way, of an idea which a subsequent inventor has really reduced to practice, and thus prevent the real inventor from getting his patent. So that there arises a very serious evil from such patents. They are not ripe fruit, and constitute in their greenness mere obstacles in the way of others who have carefully planted, pruned and cultivated. Therefore it may be well to take this problem in hand at once, and look at it in all its aspects, and consider whether a new rule had not best be made in the premises. We are fully aware of the cheap cry that will be at once raised. An extreme case will be stated and the question then asked, "Ought the inventor to be compelled to go to any such expense of time and money?" But any such supposed case will not be the fair average. So the question to be really discussed is whether on the whole it is best to set some such a bound as a condition precedent to application.—*American Inventor.*

The Holophotometer With Stand.

We described in our last issue the principle upon which these instruments is based, and the method of its use. We now illustrate the practical form of the holophotometer, by the Woodhouse and Rawson Company. It will be seen that the instrument is mounted upon a stand, which moves freely on three castors, *E*, and after being placed in position is fixed by means of three screw-pins, *D*, which also serve for levelling purposes.

The solid casting (into which the support of the instrument slides) is capable of considerable vertical movement, so as to suit any height of photometer disc. The fly nuts *A* serve to clamp it firmly at the required height.



FIGS. 1, 2 and 3—THE HOLOPHOTOMETER.

The whole body rotates about a centre-pin moving in the casting; and the exact position of the arm at right angles to the upright is insured by the pin *B*, which drops into a conical slot in the casting.

Rotation of the arm is prevented by the pin *C* and the adjacent set screw.

Fig. 1 shows the instrument as seen from the photometer disc, the rotating arm being in a horizontal position, and consequently the image in the mirror is a horizontal image of the incandescent lamp suspended behind.

Fig. 2 shows the arm vertical, and the image that of the lamp as seen from below.

Fig. 3 shows how the whole instrument is turned about *B*, so as to enable the direct, horizontal light of the lamp to be measured in estimating the absorption of the mirrors. —*London Electrician.*

—— The Boston Electric Light Company have recently ordered from the Brush Electric Company, of Cleveland, Ohio, 25 double arc lamps, 2,000 c. p.

"TELEPHONE BATTERIES."

PAPER READ BY F. A. PICKERNELL BEFORE THE TELEPHONE CONVENTION, SEPTEMBER 4TH, 1888, AND THE DISCUSSION.

I shall not attempt in these notes to recommend or describe any particular battery, but shall content myself with pointing out defects existing in the batteries now commonly used for transmitters, and emphasizing the importance which all telephone batteries ought to possess.

The selection of batteries for transmitters has always been a matter of considerable importance, although not always recognized as such. When the battery transmitters were first introduced nearly all telephone wires ran on overhead structures, no cables being used. The retardation in these circuits were consequently slight, and it was during this period of the business that the large margin in transmission was observed, it having been found possible to talk with the same ease over circuits 50 miles long as it had previously been over circuits a mile longer. This led naturally to poor construction, lines being built with small gauge iron and steel wire, and in many cases without insulators. Such construction cut down this margin of transmission to such an extent that it was found impossible to talk over such lines in bad weather unless the transmitter and battery were in the very best condition.

Better construction followed, and with better construction the battery problem was of less importance. More recently, however, the extensive introduction of cables has again cut down the *margin* of transmission. This of course renders it necessary to keep the transmitter and its battery in better condition. As the cable system of any telephone exchange increases, in a like ratio will the importance of battery problem increase. It was only last week that a gentleman was telling me of his experience in confirmation of this. His company had a cable 2½ miles long which not only had a high electrostatic capacity but also a high resistance. This cable was used mainly for trunk wires. It was noticed that many subscribers who had no difficulty in talking with parties in their own exchange, had considerable difficulty in talking with parties in the other exchanges connected through this cable. Upon inspection it was found that invariably a poor battery was found at the subscriber's instrument. This cable made a very good battery inspector, and one, I may say, that did not ruin the transmitter in inspecting.

The battery most commonly used for transmitters is of the Leclanche form. The little attention required by a battery of this class, its freedom from violent acids, the ease with which it is set up, its small consumption of zinc, there being no consumption when the battery is on open circuit, all unite in making it the leading form of telephone battery. However, it polarizes rapidly and has a high and constantly increasing internal resistance when worked over a low resistance circuit, as it invariably is when used for transmitters. The importance of low battery resistance is clearly shown by the following considerations:

The efficiency of any transmitter, other things being equal, is proportional to the variation in current strength produced in its primary circuit. The greater the variation in current strength the greater being the efficiency. The variation in current strength being proportional to the variation in resistance it follows *that* the efficiency of any transmitter is proportional to the variation produced in its primary circuit. The following table calculated for a Blake transmitter shows how important is the part battery resistance plays in modifying this variation in resistance, in other words, in modifying the efficiency of the Blake transmitter.

This table assumes the variation in a Blake transmitter to be from 5 to 15 ohms, these figures being the result of many measurements.

Table for Blake transmitters. Resistance of primary circuit of induction coil, 5 ohms:

Battery Resistance.	Minimum Resistance.	Maximum Resistance.	Ratio of Min. to Max.	Percentage Decrease of Ratio from that of Battery of no Resistance.
.0	5.50	15.50	1 : 2.82	
.33	5.83	15.83	1 : 2.72	3.6
.67	6.17	16.17	1 : 2.62	7.1
1.00	6.50	16.50	1 : 2.54	9.9
1.33	6.83	16.83	1 : 2.46	12.8
1.67	7.17	17.17	1 : 2.39	15.2
2.00	7.50	17.50	1 : 2.33	17.4

Two ohms is not an uncommonly high resistance for Leclanche batteries, and, from the table, we see that the variation from its minimum resistance to the maximum resistance of the primary circuit of a Blake transmitter decreases from a ratio of 1 : 2.72 in the case of a battery of .33 ohms internal resistance to a ratio of 1 : 2.33 in the case of a battery of 2 ohms resistance, a decrease of 14 per cent.

With L D transmitters the battery resistance is an even more important factor, as will be seen by the following table:

This calculation for long distance transmitter assumes variation in resistance to be from 4 ohms to 20 ohms resistance of primary of induction coil .45 ohms.

Three cells of Laclanche battery are generally used with this transmitter.

Battery Resistance.	Minimum Resistance.	Maximum Resistance.	Ratio of Min. to Max.	Percentage Decrease of Ratio from that of Battery of no Resistance.
.0	4.45	20.45	1 : 4.60	
.33	5.45	21.45	1 : 3.94	14.
.67	6.45	22.45	1 : 3.48	24.
1.00	7.45	23.45	1 : 3.15	32.
1.33	8.45	24.45	1 : 2.89	37.
1.67	9.45	25.45	1 : 2.69	42.
2.00	10.45	26.45	1 : 2.53	45.

From this table we find that the variation is decreased from 1 : 3.94 when batteries having internal resistance of .33 ohms are used to a ratio of 1 : 2.53 when batteries of 2 ohms internal resistance are used.

These tables likewise show why it is that even a slightly defective joint in the primary circuit prevents the action of the transmitter.

Polarization is a defect of even more importance than internal resistance. It is not uncommon for a Leclanche battery to decrease 30 per cent. in E. M. F. after 10 minutes use. This, of course, decreases the average current in the primary circuit of the transmitter in a like ratio.

Having noticed now the importance of low and constant internal resistance and constant E. M. F., I will next call attention to some of the causes which operate to render telephone batteries not only poor to start with but unreliable in service. Lack of porosity in the porous cups is frequently the cause of high battery resistance.

Commonly porous cups are found which contain peroxide of manganese dust. This dust should never be admitted, as it invariably increases internal resistance. The peroxide should be in particles about the size of small peas. Binding posts are frequently found which do not make good connections with the electrodes. The binding post on the carbon plate is often found after a few months use to be almost entirely insulated from the plate. This is caused by the salts creeping up through the carbon and corroding the metal binding post. The upper portion of the carbon is supposed to be entirely impregnated with paraffine to prevent this crawling, but very often the carbon is not *soaked* long enough to become thoroughly saturated. Care must be taken not to use an excess of sal ammoniac in setting the battery up, for otherwise crystals will form on the zinc, increasing very much the internal resistance. If the sal ammoniac becomes impoverished, a complicated chloride of zinc will deposit in the same manner.

A poor quality of the peroxide of manganese is frequently found in porous cups. When such is used, polarization takes place very quickly.

Gravity batteries and bichromate of potash batteries have been used to a considerable extent, especially for L D transmitters. These batteries require much more attention than the Leclanche battery, and are not so reliable. The battery which, in its electrical properties, approaches more nearly the ideal battery is the storage battery. This combines constant E. M. F. with very low internal resistance. Two cells of storage battery on an L D transmitter give the very best transmission.

This form of battery cannot of course be generally used on subscribers instruments.

Many modifications of the Leclanche battery have recently been introduced, some having remarkably low resistance, but they all polarize more quickly than is desirable. I think that if we have not already a modified Leclanche battery that combines low resistance with constant E. M. F., that we will soon have one, and this will be beyond question the telephone battery of the future. I see no reason why a battery of this kind could not be made having an internal resistance of considerably less than .5 ohms and a constant E. M. F. of 1.48 volts. This battery could be put up in a package with nothing but the terminals projecting, and these I may say should be provided with the best possible forms of binding posts. By using nothing but the best material and properly designing the electrodes, polarization could to a very great extent be prevented, and by properly proportioning the components exhaustion would take place in all the parts at about the same time. Such a battery would give when set up the very best possible results, and would require no inspection. When the battery became exhausted, no unsatisfactory doctoring would be done by the inspector, he would simply replace a battery by a new one. Until some such battery is generally introduced, we may expect about the same percentage of battery troubles as we are now having.

Mr. Gifford: I have not the pleasure of knowing the gentleman who just read that paper, but I understand he is comparatively a young man with us. I want to say that while we have discussed conductivity, resistance, insulation, and all those topics until they have got to be chestnuts almost, this is really the first exhaustive and specific paper on the subject of batteries that we have ever heard, I think. It is a very valuable paper, and I move that we return the thanks of the Association to the reader of the paper.

Mr. Bailey asks a question of Mr. Pickernell in relation to storage batteries.

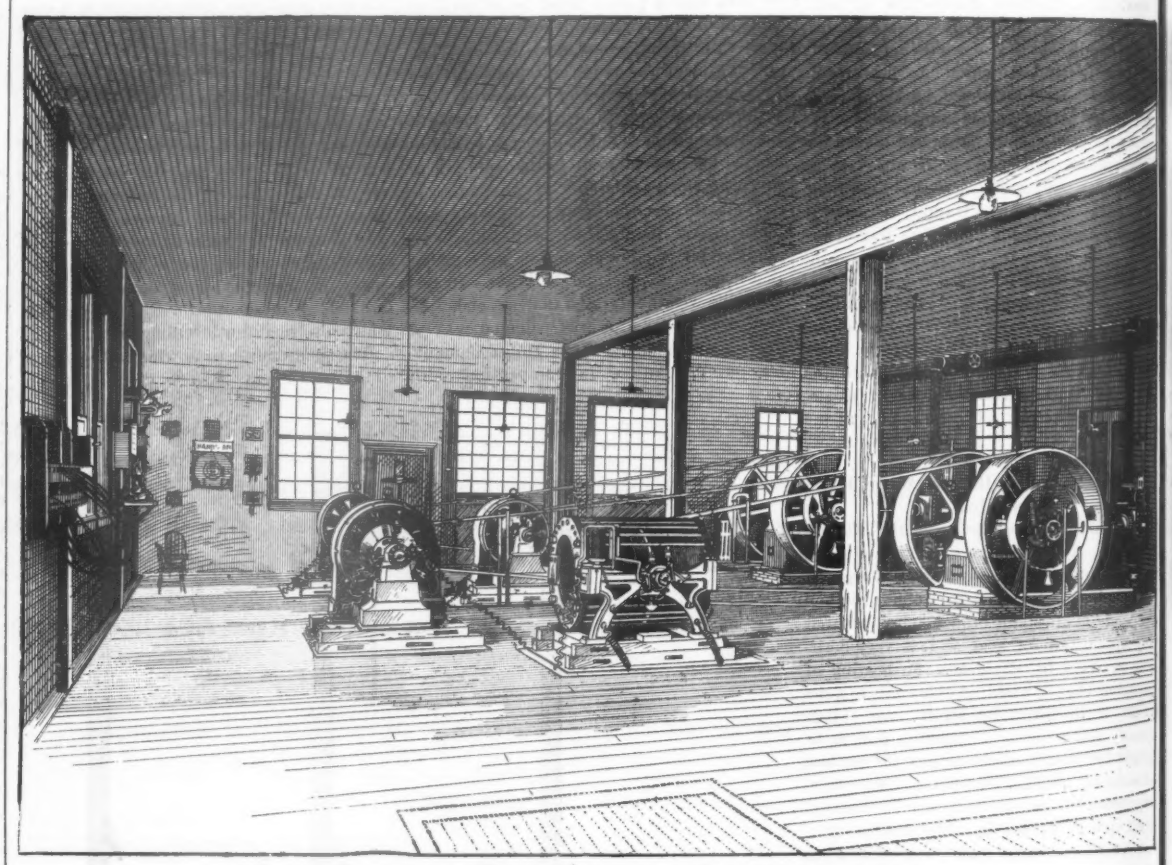


FIG. 1.—INTERIOR OF THE ELECTRIC LIGHT STATION AT NARRAGANSETT PIER.

Mr. Pickernell: The batteries I referred to were the old form of Brush, the first form that came out. I should say that the size was five by eight by twelve. The two cells of storage battery had two plates each, and the resistance was very low indeed. I did not use the batteries after the electro-motive force had commenced to drop out appreciably.

Mr. Gifford: There is one other question I would like to ask. I noticed Mr. Pickernell, in his paper, mentioned the fact that he used three Leclanche cells usually with the long distance transmitter. I wish to say that we have several of them in use. I started out rather on my own hook to see how many cells were wanted. I commenced with one, two, and three, and I carried it up to four, and on the line on which we have them in use I found that four cells gave the best result. But, I assume that I have a good deal to learn on that subject, and I would like to hear from some of the members in the Eastern States as to what they usually use, and what number they find produces the best result, and what battery will go farthest. While I do not wish to have the Association espouse the interest of any particular battery, I would like to know what battery has been found to be the best for long distance transmitters. That is a practical question that we can discuss here without reflecting upon any particular battery, I think.

Mr. Seeley: I would like to state to members of the Convention that the Metropolitan Company, of New York, are putting in a storage battery for their transmitters, especially for the exchange work. We are about to use a cell we call "Tight D," giving seven amperes of current internal resistance to about $\frac{5}{1000}$ of an ohm two volts. Those batteries are about seven inches high by 12 inches square.

Mr. Lockwood: I need scarcely say that I was much pleased with Mr. Pickernell's paper. I am glad to see that the younger men amongst us take sufficient interest in our work as to take the time and pains to write papers for this Association, and I am also glad to see that a spirit of discussion is abroad, because I think we learn just as much from the discussion and from the individual experience of the members as we do from the papers themselves, and sometimes the information we gain from the experience which is given is more valuable in a practical way than that contained in the paper itself, whose real value must of course always be that of the discussion which it elicits; and I trust that the discussion of the papers which are read at this meeting of the Association will be more prevalent and universal than it has been. I notice, however, one point in Mr. Pickernell's paper, which, since it differs from my own experience, I think it proper to refer to especially. It may be that my experience is a misleading one, and that I am wrong on this point. If I recollect right, he stated that we were to be careful in the use of Leclanche batteries, not to use too much sal-amoniac. If by using too much he means that we are not to fill the jars full and then try to moisten it, I agree with him. If on the other hand, he means that we must be very chary about putting sal-ammoniac in, I cannot agree with him. As a matter of fact, I have found in the course of some 13 or 14 years experience in telephony and otherwise, that the amount which the dealers, especially the Leclanche Battery Company (who are very careful to send out nothing but good material) that the amount which they send out of sal-ammoniac, is exactly the amount which it is proper to use. In my experience I have found that the amount they put up in their paper packages is just about the correct amount, and that we can neither diminish that nor increase it with advantage. It is true that crystals will form upon the zincs and upon the lower part of the zincs, but as long as crystals of sal-ammoniac only fall on the zinc, no great harm will come. It is also a fact that when there is a little sal-ammoniac in the solution, oxychlorides of zinc and ammonium at once form on the zinc, and these salts being insoluble, take away so much of the conducting surface of the zinc, and thus increase the resistance of the battery, besides preventing the necessary consumption of the zinc, which is absolutely essential to the proper working of a battery. I did not notice any other point in the paper that I should care to criticise at all, and it may be that this is simply a difference in definition. I dare say when Mr. Pickernell comes to re-state his views they will be found to be not far from this which I have enunciated.

I am also very glad to note from what Mr. Seeley says, that the Metropolitan Company is making an experiment in the way of using secondary cells. I should like, if I may be allowed, to place myself in front of the Association for the moment, to request Mr. Seeley to do, what I have no doubt he will do, to make a careful observation of the result of such batteries, so that at our next meeting we may be enabled to know something about it. Of course, if we had a storage cell, if we had a secondary battery with just sufficient voltage, and furnishing just sufficient current for our needs, no doubt that would be the ideal cell. If we should use such a cell, of course we should be subject to the necessity of re-charging, but the Leclanche cell is not wholly free from such disadvantages. The best batteries we have had in our telephone work have to be looked after. In 1882, when I was in Cincinnati on a short visit, I found that the Cincinnati service was far ahead of anything that I had ever seen in any exchange before, and when I came to look into the matter I ascribed it more particularly to the constant inspection and the great care exercised by the City and Suburban Telephone Association of Cincinnati, in looking after their batteries then.

Mr. Pickernell: I would state that I quite agree with Mr. Lockwood tn respect to his statement about the use of sal-ammoniac. I mention that fact because I found that it was not infrequent for telephone inspectors to put in two of those packages of sal-ammoniac instead of one, thinking that by so doing they might possibly save a trip there in a short time. It is only about two weeks ago that I found three cells of battery which we were using on a long distance transmitter in which the zincs were entirely covered with crystals of sal-ammoniac. The reason my attention was called to that fact was that the transmitter would not work at all; still there was a circuit; you could get the click all right when you moved the telephone hook.

The President: How many ounces of sal-ammoniac does the Leclanche Company furnish?

Mr. Pickernell: I think it is four ounces.

Mr. Gifford: It used to be six.

Mr. Pickernell: In reply to the gentleman's question about the number of cells to be used with long distance transmitters, we find, if we use low resistance batteries, that three cells are as good as four, there being practically no difference. But if you have batteries in which the resistance is increased from any cause whatever, it may have been unusually high resistance, you will find that four batteries are better than three. In other words, if you should try to make the experiment by first putting on one battery and talking, and then two and three and four, if you start with a battery having high internal resistance, you will find four will be enough. On the other hand, if you use batteries with low internal resistance, you will find three quite as good as four. Of course with three the chances of trouble are less than with four.

Mr. Gifford: In selecting batteries for our long distance work we are very careful to see that our batteries are as nearly perfect as possible. When the millenium comes I suppose we shall have perfect batteries; not be-

fore. I am always very careful to select good batteries and I have found that in some instances four cells give better results than three, although three have worked very well. One word in regard to sal-ammoniac. That is one of the questions that vary somewhat in different localities. A short, practical rule that I have adopted is to allow an inspector to put in no more sal-ammoniac than you can dissolve in water. I do not leave any at the bottom of the cell at all. I found, as Mr. Lockwood says he found, that they will load up a cell with two or three charges, so that they will not have to go back. I only allow them now to put in as much as you can dissolve. That varies according to the kind of water in different towns. In a town where you use lime water it will not hold so much sal-ammoniac in suspension as pure river or rain water will, and in some places where you happen to have water strongly charged with some mineral it will not dissolve very much. That varies a little. I mention that more as theory than practice. Of course I do not suppose it will make a variation of half an ounce in practice.

Mr. Thornberry: I would like to ask the gentleman if he finds any deposit on the zinc on the treatment of the battery which he carries out?

Mr. Gifford: Sometimes you do, sir. When I am careful not to overcharge the battery I do not find near as much. I presume there is hardly any battery but what, if you use it long enough, there will be more or less deposit of zinc. Where you do not overcharge it, it does not deposit nearly as much.

Mr. Thornberry: I was going to say, in my experience I rather favor the disposition of the batteries described by the gentleman who last spoke, in placing just enough sal-ammoniac in the battery to keep it doing its work. I find that the battery, if it is put to hard work, even though it has just sufficient to do the work without more, will deposit these crystals on the zinc. They are undissolvable, and therefore the battery has no zinc in contact with the solution. For that reason we get no current. The value of any battery is proportionate to the current it will give us. That is determined by the internal resistance. I want to say, in reference to the long distance telephone, that where hard work is being done the Leclanche battery will hardly answer the purpose, if it is in an exchange where it is used frequently; but a four or six cell gravity battery will serve the purpose just as well. That is to be determined by the length of the line in which you wish to work it, or the condition of the battery itself. The sulphate of copper battery, or gravity battery, as we call it, has to be constantly at work or it will polarize itself. If it is constantly at work and cleaned once a week, the gravity battery will give splendid results and give you splendid transmission for your long distance telephone; but we determined some years ago, when this telephone first came up, that four cells of the Leclanche battery were the best. The first experiments we made were with the Fuller battery. We used three of those and that gave us six volts, and the internal resistance was about the same as the Leclanche, and then we used the four Leclanche cells, which gave us in the neighborhood of six volts.

Mr. Bailey: The point aimed at seems to be to get an effective working battery of low internal resistance. The gentleman was speaking of the use of a storage battery. Why isn't that of some value? Has any one experimented with the Leclanche batteries on any kind of telephone, in multiple? In using them in multiple you would get much lower internal resistance, I should say, and of course a greater quantity of current.

Mr. Lockwood: I did not intend to say anything more on this head, having said my little say, but since the gentleman from Pennsylvania inquired, I might add that some two or three years ago the chief clerk of our company, Mr. R. W. Devonshire, sent me two or three transmitters with the instruction—I don't know whether it was directed to me specially, or whether it was in the nature of a circular—which gave me the exact information how much battery I ought to use for the long distance transmitter. I did not follow the instructions with great care, and I tried them with a number of cells of different kinds. I tried them with one, two, three, four cells of Fuller and different bichromate combinations. I tried them with one, two, three, four, five, six cells of Leclanche and other similar batteries, and I tried them, as Mr. Bailey has spoken of, three in tandem and two abreast—three in series and two in multiple arc—and I found that while that arrangement was new it worked beautifully. It furnished the proper amount of current, or at least it furnished a very good amount of current, and it worked very nicely; but when that battery grew a little older I found that it did not work as well because it was impossible to make the two sides work alike—one side got a little stronger and kept getting a little stronger than the other. Consequently, instead of both points of the current going *this* way, the stronger battery took a notion to polarize or go against the current of the other side. While it was new it worked very nicely, but after two or three weeks it did not work so well. A better way would be to do, what I am surprised battery manufacturing companies have not done before—is to make a larger Leclanche cell. Possibly they have done it before, but it has not got into the market. A demand has come, however, for a Leclanche cell about twice the size of the present cell. I have a Fuller battery under my desk and it has worked unchanged for eight months. It works pretty well and you could not tell from the operation whether it was an old battery or that it had not been cleaned for eight or nine months. As there are only two cells it does not make much gas and does not annoy me at all. But while acid is good in an office like mine or in the headquarters of a telephone company, it is not good for subscribers' stations. So I think that we shall have to put our trust still in the peroxide of manganese battery until we can find that peroxide of lead is as constant as peroxide of manganese and it is a proper thing, I think, for manufacturers to consider whether they had not better increase the size of them.

The point mentioned by Mr. Gifford, or some other gentlemen, that the batteries which the Leclanche Battery Company once provided six ounces they now only provide four; that can be accounted for by the fact that there are several sizes of Leclanche batteries, and they have provided six for the larger size and four for the smaller size, and it is always economy where we are buying for telephone transmitters to buy the larger size.

Mr. Seeley: The present plan of the Metropolitan Company is to make an inspection once every month. The solution is thrown out and a new solution made up. Each inspector is provided with a measure holding four ounces of sal-ammoniac. We guard against overcharging the batteries in that manner. We find that the Gouda-porous cup is about as good as the Leclanche battery. Taking the current at the electrodes of the battery we find that we get one and seven-tenths volts with an internal resistance of one and seven-tenths ohms. After using that battery through a resistance of eight ohms for five minutes we find that the voltage falls to one and three-tenths, a current of five-tenths of an ampere and the internal resistance has increased to two and six-tenths volts, etc., down the short circuiting of the battery. For an hour and five minutes we get three-tenths of a volt and three-tenths of an ampere and one ohm internal resistance. That battery was far ahead of any we experimented with.

Electric Roads will Come.

The contract for building the power station for the new electric railway of the West End system has been awarded to the Jarvis engineering Company of Boston. The building will stand in Braintree street, Allston. The plans were drawn by F. M. Whiting, inspector of buildings for the West End Street Railway Company. The contract specifies that the building must be finished in six weeks.

A Model Electric Light Station.

We give this week cuts showing the exterior and interior views of the station recently completed by the Thomson-Houston Electric Company of Boston, for the Narragansett Pier Electric Light and Power Company, of Narragansett Pier, Rhode Island.

As is readily seen, the outside design of the station is novel, and is fully in keeping with the architecture of the hotels, casino, and cottages of this wealthy resort.

The engine and dynamo room is finished in white wood, and in arrangement is similar to that used to a great extent in many stations. The present capacity of the station is 2,500 incandescent (alternating), and 50 arc lamps, and ample room is left to add steam plant and dynamo capacity sufficient to operate as many more.

The second story is used as a stock and lodging room, three nice chambers being fitted up for the use of the employés, the superintendent occupying the one in the tower directly over the office. There are few rooms at the pier which surpass these for comfort and a fine view of the ocean.

By a unique arrangement of Mr. Burleigh, of the Thomson-Houston Company, who had charge of the installation of the plant, all the incandescent lights can be thrown on one machine, during the latter part of the night, thereby giving to patrons all the service needed at the time, and permitting all the engines and dynamos except one to be shut down.

The steam plant was furnished by the Jarvis Engine Company, and is complete in every respect, being fitted with muffler, extra valves, damper, regulator, etc.

The outside construction extends from the Boston Neck road on one side, to the elegant cottage of Mr. R. G. Dunn on the St. Judith road on the other, and covers the district from the water front back towards Wakefield.

All the hotels, casino, and many of the cottages, have adopted this method of lighting, and are very much pleased at the result, the largest patron being the casino, which is using nearly 450 lights, and which has given the company a contract for five years for lighting the building.

Many owners of cottages are now leaving orders to have their residences wired during the coming winter, and the outlook for 1889, added to the very successful start of this year, makes the prospect of this plant most flattering.

Although the largest amount of business will be done during the summer months, the station will be run the entire year. The construction of lines is already under way to connect the plant with Wakefield and Peacedale, only two miles distant, where a large business will undoubtedly be secured, as a large number of lights which are used in the summer and not in winter, can be successfully introduced into several of the large mills there.

Construction work was commenced April 25th, and the lights were turned on June 20th.

The officers of the Company are: President—John Babcock, Wakefield, R. I. Treasurer—John B. Kearney, New York. Directors—John Babcock, Wakefield, R. I.; John B. Kearney, New York; Edw. Earl, New York; William C. Clark, Wakefield, L. I.; Thos. T. Robinson, Boston, Mass.

FIG. 2.—EXTERIOR VIEW OF SAME.

The Man, Not the Electric Motor, at Fault.

[From N. Y. *Evening Sun.*]

To the Editor of the Evening Sun—Sir: Will you kindly accord sufficient space to answer a paragraph appearing under the head of "Points of Personal Interest," in your issue of August 16th. It "runs amuck" among electrical railways, and is so evidently the result of misinformation as to invite earnest missionary effort to bring light to its darkness.

There are probably 30 electric railways in the United States and Canada, all working upon a commercial basis, and the Daft system—among which is the Pittsburgh, Knoxville & St. Clair road, whose mishap of the other day has been magnified out of all recognition—has ten of them. There is no foundation whatever for the blank hopelessness of the paragraph in question.

Apropos of the incident at Pittsburgh, it has been so outrageously misrepresented that, in simple justice, it should be exhibited in its true light. The road has no equal in the world for extreme gradients and sharp curves. One of the first is of 15 $\frac{4.5}{10.5}$ per cent., and that mechanical tractors could surmount such has heretofore been deemed impossible. A gentle horse will sometimes run away from a nervous driver, and this is precisely analogous to the runaway motor. It did not become "unmanageable," but an incompetent driver, with mechanical and electric brake, as well as reversing power at his command, deserted his motor in a panic just as it was entering upon the maximum gradient and a curve of 50 feet radius, and the natural result followed. Any horse will run away if the driver leaps from the wagon. The motor ran 400 yards, rounding two curves, one of 52 and the other of 27 feet radius, and came to a standstill at the bottom of the slope. No one was hurt, no important damage was done to the motor or anything else. The brakes and reversing gear were in good order, and the motor ready to run again in a short time. The trouble was with the man, not with the machine, whose wonderful strength and stability are shown by its rounding at such high speed the sharp curves mentioned.

Will you, in the interest of truth and justice, give this explanation a chance to be read? Respectfully,

THOS. WHITESIDE RAE.

Daft Electric Light Co., Greenville, N. J., August 17th.

ELECTRICAL REVIEW

Published at 13 Park Row
P. O. BOX 3329.

GEO. WORTHINGTON, - - Editor.
CHARLES W. PRICE, - Associate Editor.
T. J. McTIGHE, Electrician and Manager Patent Bureau.
L. N. DOWNS, - - - President.

REGISTERED CABLE ADDRESS:
"ELECTVIEW," NEW YORK.
TELEPHONE CALL, 546 JOHN.

SUBSCRIPTION.

United States and Canada, $3.00 per annum, in advance. Postage paid by publisher.
Great Britain and other foreign countries, $4.00, in advance. Postage paid by publisher.

ADVERTISING.

Transient, 25 cents per line, nonpareil.

NEW YORK, SEPT. 15, 1888.

CONTENTS.

	PAGE.
Lombardy Poplars as Lightning Rods	1
Jointing Phosphor-Bronze Wires Without Heat.	1
Must an Invention be Reduced to Practice Before Application for Patent	1
The Holophotometer With Stand	1
"Telephone Batteries"	1
Electric Roads Will Come.	3
The Man, Not the Electric Motor, at Fault	3
The REVIEW Last Week	4
Alternating *vs.* Direct Currents	4
The Telephone Convention	4
New York Headquarters	4
Gefunden—A New Principle	4
How They Were Entertained	4
Manufacturing Notes	5
Echoes of the Electrical Gathering	5
The New Constitution	5
New Corporations	5
Telephonic News	6
Making the Telephone Useful	6
Telegram Stealing	6
Electrical Education	6
The Electric Road at Salem	7
"Overhead and Underground Wires in New York"	7
Quick Break Switch for Large Currents	9
Electric Light News	9
The Work of the Telephonists	10
Perforated Leather Belting	15
The Telephone	15
The Telephone Exchange of New York City	15
Electrical Patents	16

The REVIEW acknowledges with unfeigned gratification the many words and communications of congratulation it has received over the issue of September 8th. We are not prepared to dispute the enthusiastic subscriber who says it was the "most complete and most intelligently edited electrical journal ever published and the electrical fraternity are proud of it." That is the way the REVIEW does things.

Those who favor the burial of all electric light wires underground out of sight, apparently overlook the difficulty to keep those out of reach also, namely at their connections with the overground lights. This is no doubt easier with the existing system of overhead wires when placed all out of reach, while the sufficiently protective insulation may as well be applied to such wires as in the case with the underground lines.

The agitators who want legislative interference against the use of high tension dynamos should be consistent, and if the protection of human life *is their real motive*, they should attempt to obtain also legislation against the manufacture and use of high tension dynamite, nitro-glycerine and other dangerous explosives; further against the use of gasoline lamps, burners and stoves, all of which produce almost daily their quota of victims. Further against horse and footraces, rowing and swimming matches, base and football games, athletic sports, etc., as each of these have from time to time produced more accidents or loss of life than is the case with the electric light currents, about which it appears to be the fashion to make a great bluster when occasionally a life is lost, while the killing of a baseball player or a jockey attracts scarcely any notice.

THE REVIEW LAST WEEK.

The past two weeks have been crowded with electrical "meat." It was an easy matter to fill up an hundred page journal. But American readers don't want that. They prefer the *cream*—and that can only be secured, where there is such a mass of important matter, by the exercise of editorial brains.

The ELECTRICAL REVIEW appeared on time last week, and we submit, without fear of questioning, that it comprehended the situation, difficult as it was.

Bearing date of September 8th and mailed in the forenoon of Wednesday (September 5th), as is our custom, the following comprised a portion of its contents:

Complete report of the proceedings of the National Electric Light Association, papers, discussions, etc.

The valuable list of names and addresses, alphabetically arranged, of the 370 attendants on the Sessions of the Electric Light Association.

Full account of the entertainment provided for the visiting electric light men, including dinner to the Executive Committee, visit to the "Fall of Rome," and the liberal handed hospitality of the Okonite Company, consisting of the largest theater party New York ever saw given by one company and an appetizing collation at the Electric Club afterwards.

Verbatim report of the interesting speeches at the Morrison and Westinghouse testimonials at the Electric Club Friday afternoon.

The carefully compiled list of all exhibitors, making a magnificent showing of the great appreciation which this important Convention is receiving at the hands of the commercial public.

The interesting account of the memorable steamboat excursion to the Phillips Clam Bake, with all its attendant entertainment, including visits to Newport, the U. S. Torpedo Station, etc., etc.

The Telephone Convention proceedings up to Wednesday morning, with a full account of all that had transpired, including names of newly-elected officers, reports of secretary and treasurer, summary of the president's address, action of the Association in deciding against secret sessions, and the correct announcement of the programme of Wednesday and Thursday.

List of names of all Telephone Convention attendants, and companies represented.

Names of companies having exhibits at the Telephone Convention.

In addition to the above, the REVIEW published a number of illustrated articles, list of new corporations, and general electrical news, and in its editorial columns reviewed the proceedings with its accustomed discernment.

We think our readers one and all, found something to interest them in the REVIEW last week.

And we think they will, also, be interested this week.

ALTERNATING VS. DIRECT CURRENTS.

The haste with which the paper under the above title was prepared by Dr. Van der Weyde resulted in some erroneous conclusions based on a superficial examination contained in the first draft of the paper, which he acknowledges, and therefore partially corrected in the paper as read before the Electric Light Association.

He will publish a pamphlet edition of the paper as it was intended to be, which will be distributed to all interested.

Under date of September 8th, a prominent electrical gentleman of Cincinnati, writes: "I wish to congratulate you upon your issue of this date. It is by far the best of the electrical publications." It is from such reliable authority as this that the REVIEW is justly proud to be commended.

THE TELEPHONE CONVENTION.

The New York convention of telephone men was all that could be desired. The papers were particularly able and practical, and the opening address of the president showed him to be abreast of the times. The telephonists are never idle, and are to be found working at the front every time.

The two chief topics were the interference from stronger currents and the burial of the wires, and we think a good deal of new light was shed upon both questions. Some new and valuable points in relation to telephone batteries were brought out in the paper of that bright young electrician, Mr. F. A. Pickernell, of the American Telephone and Telegraph Company, and very interesting statistics relating to the mammoth telephone system of New York City, were intelligently presented by Mr. E. F. Sherwood.

NEW YORK HEADQUARTERS.

The action of the National Electric Light Association in deciding to open permanent headquarters in New York, with a capable electrical engineer in charge, was most wise and urgently demanded. This Association is too strong and too influential to be without permanent headquarters, where its members can receive pertinent information at all times, a right that their membership should guarantee. President Duncan's clear, good sense will see that the right man is appointed, and we expect to see the office grow in importance and interest from month to month after it is established.

The electrical business is not to be measured by rules that fit other industries, and these permanent headquarters will be productive of great good, we dare predict, to the entire field of electrical science.

GEFUNDEN—A NEW PRINCIPLE.

Some one once asked Commodore Vanderbilt why he listened so attentively to a certain superficial and garrulous person, and he replied, saying, with many vigorous accentuations in his speech that any fool could learn him *something*.

While looking through a recent issue of a contemporary, which is stated to be "a weekly review of current progress in electricity and its practical applications," on the title page, we learned of a new principle in electrical conductivity; when we double the diameter of the wire, we also double the circumference, it is undeniable that we quadruple the sectional area. Consequently we but double the capacity, *while we quadruple the resistance.*

The idea that an enlargement of a conductor increases the resistance is decidedly refreshing on a warm day.

Editor Kreidler of the *Western Electrician* is to be congratulated on the last issue of his journal. It was edited at long range, the editor remaining in New York, and thoroughly covers the Electric Light Convention, and intelligently comments on the prominent features of the convention in its editorial columns.

Undergrounding of arc-light wires did not get much of a boost of approval from the convention—that is as so far proposed. The lighting companies' representatives who had experience seemed to throw cold water on it. It was not practicable for distribution as yet. Subways might be constructed and the whole city underlaid with elongated rat-holes, but the problem still involved the wherewith to put in the holes.

Mr. Chas. A. Brown, of Chicago, manager of the Western Electric Company, who was one of the valiant workers in the organization of the Electric Light Convention in Chicago in February, 1885, was in attendance for the first time since then and renewed old acquaintances in many directions.

President S. A. Duncan proved to be the right man. He is a careful, conscientious presiding officer, and his work at this, his first convention, as presiding officer, showed that the Association could but continue to advance under his able guidance.

HOW THEY WERE ENTERTAINED.

THE TELEPHONE MEN RECEIVE MOST HOSPITABLE TREATMENT WHILE IN NEW YORK.

The visiting telephone men who spent last week within the charmed precincts of Manhattan Island had a very enjoyable as well as profitable time. The convention continued for two days, and the hard work of the second day was made amends for by the entertainment that followed. The first relaxation came Tuesday evening, and was the kindly gift of the

AMERICAN BELL TELEPHONE COMPANY.

This consisted of a theater party at Niblo's, which was arranged and managed by Mr. Thomas B. Doolittle on behalf of the parent company. The telephone men attended in full force, all wearing the little gold badges, in the shape of a telephone receiver, that by thoughtfulness of Secretary C. H. Barney had provided. The other theater-goers that night were at a loss to know the meaning of the presence of such a fine-looking body of men, each one decorated with the telephone pin. The next day at 3.30 P. M. the

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

brought seven tally-ho coaches to the Hotel Brunswick, which were soon covered with the telephonists, and a very delightful drive through Central Park, Riverside Park and along the Boulevard was enjoyed. The drive included a visit to the lines of the company, built for long-distance use between New York and Boston, and the splendid construction was greatly admired. The ride was a very happy thought, and many were the compliments bestowed on General Manager Ed. J. Hall, of the A. T. & T. Company, for his considerate act in giving the visitors a scenic treat that they will never forget. A visit to the tomb of General Grant was taken, and at 6.30 P. M. the party arrived at the new Mt. St. Vincent restaurant, Central Park, where a photograph was taken on the lawn. It was here that

THE WESTERN ELECTRIC COMPANY

designed to show its appreciation of the visiting telephonists, and at 7 o'clock invited them to sit down to an elaborate banquet. The menus were charming little works of art, each with a different and appropriate Shakespearian quotation in gilt on the cover.

Mr. H. B. Thayer, the manager of the Western Electric Company, New York, presided, with President Metzger, Theo. N. Vail, and Ed. J. Hall on his right, and Mr. C. Jay French, Secretary C. H. Barney and Toastmaster Chas. Dutton, on his left. There were present about 150 persons and the banquet continued from 7.15 to 11.30, concluding with a number of toasts. The speakers were C. Jay French, Morris F. Tyler, Geo. F. Durant, Chas. Glidden, T. D. Lockwood, W. J. Sefton, D. L. Gibbons, F. W. Jones, H. L. Storke, R. W. Pope, W. A. Hovey and others. The remarks were all well received and applauded. Mr. Tyler, as usual, made a capital speech, and spoke words of praise for the Bell Company and its great victory in the courts, stating that the legal contest had been the most magnificent ever waged. In the course of Mr. Gibbon's remarks, he paid a compliment to Mr. T. N. Vail, and the audience seemed to go wild. For several minutes the cheering and applause continued. It was a splendid reception, and one that must have proven to Mr. Vail that he was still the owner of a very warm place in the hearts of the telephone men. The banquet concluded with cheers for the Western Electric Company and its able and greatly liked New York manager, Mr. H. B. Thayer. The tally-ho coaches carried a lively party down to the Brunswick, arriving there about the midnight hour.

THE METROPOLITAN TELEPHONE AND TELEGRAPH COMPANY.

This company presented a day and an evening of entertainment that will for many years remain fresh in the minds of the participants. The iron steamboat "Cygnus" was chartered for Thursday, and at 11 o'clock left the city, loaded with telephone men and

several ladies, and steamed up the beautiful Hudson. To the majority it was a new and interesting scene. At 1 o'clock a most elegant lunch, furnished by one of New York's leading caterers, was set out and the voyagers did it full justice. The return was made to reach Staten Island by 6 P. M., and time was had for a ride down New York Bay, past the Goddess of Liberty and beyond the Narrows.

The time on the boat was most enjoyably spent, Mr. W. H. Johnstone, the inventor of the conduit system that bears his name, aiding in the pleasantness of the occasion by his aptness in calling toasts. President Vail, General Manager Eckert, Treasurer A. S. Dodd, Electrician Seeley, of the Metropolitan Company, were remembered with hearty toasts and applause, and were complimented in a way that should make them feel good for at least a year.

The dinner at 6 o'clock at the St. George Casino was a fine affair indeed, and was enjoyed by about 200 persons. Mr. T. N. Vail presided. The speakers after the dinner were Gen. H. A. Barnum, Commissioners Jacob Hess and D. L. Gibbons, A. B. Chandler, Erastus Wiman and others, and the telephone and the Metropolitan Company and Mr. Vail again received high praise.

The great spectacular play, the "Fall of Rome," to which complimentary tickets had been furnished by the same generous company, concluded the day's entertainment, unless the jolly ride from Staten Island back to New York should be named as part of the programme.

The day had been greatly enjoyed, and our visiting telephone men can certainly have but the most kindly thoughts of their brief sojourn in New York City.

Manufacturing Notes.

The Thomson-Houston Electric Light Company, of Boston, Mass., has been awarded the contract by the Kansas City Exposition Company for an electric light plant. Price, $20,000.

C. T. Richmond has been offered a position by the Thomson-Houston Electric Light Company to take charge of their carbon works at Fremont, O., the largest establishment of the kind in the world. He has accepted the position and leaves for that place early this week.—*North Adams* (Mass.) *Express.*

The demand for the Ball engine manufactured by the Ball Engine Co., Erie, Pa., is so great that they are running night and day to keep up with their orders. Beside their home demand they have recently sent engines to England, Australia, Mexico and Japan. This engine is particularly in favor with electric light and power companies on account of its perfect regulation.

The Armington & Sims Engine Company, Providence, R. I., is making a number of engines for the navy department, the engines to be coupled direct to the dynamo. But a small space is required with this "special double" engine, and the weight of the whole plant is very moderate. The company reports great success in use of this engine for those systems of electric lighting requiring a very high speed.

The New Haven, Conn., Clock Company has been sued for infringing on the patents relating to district telegraph signal boxes, owned by Leroy B. Firman of Chicago and the Western Electric Company. It is claimed that the company began to infringe August 1, 1882, and a permanent injunction is asked against it. The case has been filed in the United States District Court, but will probably not be heard before the first of next year.

The National Pipe Bending Company, New Haven, Conn., manufacturers of the National Feed-water Heater, report further orders for electric light and electric railway installations, and have just shipped two heaters for the electrical plant at Yonkers, N. Y., one 200 h. p. for an electrical plant at Montreal, Canada, one 500 h. p. for an electrical plant in the West Indies, one 100 h. p. to Pensacola, Fla., one 100 h. p. to Columbia, S. C., one 150 h. p. to Boston, one 50 h. p. to Laredo, Tex., one 400 h. p. to Brockton, Mass.; and they have orders to be filled before Sept. 15, for 1,000 h. p., one 600 h. p., one 500 h. p., one 300 h. p., and three 200 h. p.

Echoes of the Electrical Gatherings.

Col. Geo. L. Beetle was present.

The signatures of every one of the diners at the telephone banquet were secured in pencil on a series of the very neat menus.

The Electric Club was the popular *rendezvous* for the visitors. Its elegant parlors, convenient rooms, and splendid light were admired by every one.

Visitors to the various headquarters by New Yorkers were very numerous, the fair sex often honoring the electrical people with the sunshine of their presence.

The telephone people of New York kindly placed a long distance telephone in the rooms of the Western Electric Company for the free use of the electric light delegates.

A number of ladies were on board the "Cygnus," including the daughters of Messrs. Gifford, Barney, and Durant, and the wife of Mr. Chas. J. Glidden, and they all pronounced the trip up the Hudson a charming one.

Genial and hospitable treasurer Dodd, of the Metropolitan Company, who had not been as well known to the telephone men of the country, made every man he met his friend, and he will ever be remembered by them most kindly.

The directory of arc lighting plants presented by the National Carbon Company, of Cleveland, was greatly appreciated and much sought after. All who desire copies of the Directory can receive them by addressing the company at Cleveland.

There were a number of artistic designs made of fruit, sent up to the head of the table at both the Mt. St. Vincent banquet and the Staten Island one. At the latter, an imitation of a Jersey mosquito was sent up to Mr. Erastus Wiman, and its warlike proportions almost paralyzed that gentleman.

Col. M. W. Goodyear enjoyed the ride on the "Cygnus," evidently having recovered from his clam bake trip, on which occasion he declared he saw the rats desert the "Catskill" in a body, the leader mounted on a piece of a box lid, with a dust pan for a sail, and that probably explains why he took the train at Stonington.

The Okonite Company entertainment most agreeably surprised proprietor Sanger of the new Broadway Theatre by bringing two hundred and eighty-five delegates of the National Electric Light Association in to witness the new play called the Queen's Mate. This Mr. Sanger stated was the largest party ever presented at his theatre under one management.

The telephonists had a fine band on their Hudson River trip, and, after the scenery had been enjoyed, many of them participated in the dance, and a number of surprisingly light-footed gentlemen appeared. Honors were fairly even between Seeley, Hibbard, Benton, Salt, and others, until the graceful Conduit Johnstone took a hand—or rather foot—and then the palm was unqualifiedly awarded him, amid the good-natured plaudits of all the others.

The New York Subway Commissioners were evidently made more at home with the telephone men than with the electric light men. The speech of Commissioner Gibbons at the Mt. St. Vincent banquet was in good taste and received with applause; also his remarks at the Thursday evening banquet, when he was again called out. A score of guests at the banquet the night before were ready to greet him with the sibilant hiss should he attack the position taken by Mayor Hewitt, but he did not.

Some of the telephonists helped themselves to the unoccupied boxes at "Nero" Thursday evening. An attendant ordered a party out, stating the box was Mr. Kiralfy's private one. Up spoke one of the occupants: "Please present my compliments to Mr. Kiralfy, and tell him Frank B. Knight of *Texas* and his friends are spending the evening in his box." The affrighted attendant, no doubt with visions of bowie knives and revolvers, hurried away, and the party was not disturbed again during the evening.

There were several gentlemen well known to politics in the telephone party, Thursday. Ex-Judge W. H. Kelley, Gen. H. A. Barnum, Hon. Jacob Hess, Commissioner Gibbons, Hon. Fred. Lovejoy, and others, were present, and apparently enjoyed being with the lively telephonists. Mr. Hess regretted that the address he had prepared for the occasion of the banquet had been confiscated and delivered by his wide-awake young colleague, Mr. Gibbons, at the Western Electric Company's banquet the night before. This, he said, left him unprepared when called upon at the Staten Island banquet, but he had been pleased to hear that his address, as delivered by Mr. Gibbons, had been well received. This sally was greeted with much laughter.

The New Constitution.

The following is the Constitution and By-Laws as adopted by the Electric Light Association:

ARTICLE I.

NAME.

The name of this Association shall be THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

ARTICLE II.

MEMBERSHIP.

SECTION 1.—Any individual or member of a company or firm operating an electric light, power, heat or welding station for public or commercial purposes; and any individual or member of a company or firm manufacturing electric supplies or apparatus, may become a member of this Association, by the payment to the Treasurer of one year's dues.

SEC. 2.—Electricians, electrical engineers, and those whose profession or business is directly related to electrical interests or to the commercial application of electricity, may upon the recommendation of the Executive Committee and a two-thirds vote of the Association, become members thereof, by the payment to the Treasurer of one year's dues.

SEC. 3.—Upon the unanimous recommendation of the Executive Committee and the approval by a two-thirds vote of the Association, persons may be made honorary members of the Association, with all the privileges of membership, except the right to vote.

ARTICLE III.

OFFICERS.

SECTION 1.—The Officers of the Association shall be a President, two Vice-Presidents, a Treasurer and a Secretary, and an Executive Committee, to consist of the above-named officers, *ex-officio*, and nine other members.

SEC. 2.—The president and vice-presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting.

SEC. 3.—No person shall be eligible for the office of president or vice-president for more than two successive terms, but this shall not be construed to forbid the election to the office of president of one who has served as vice-president.

SEC. 4.—The secretary and treasurer, who may be one and the same person, may be nominated by the president, subject to confirmation by the Executive Committee The salary of the secretary shall be fixed by the Executive Committee.

SEC. 5.—The Executive Committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, and hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

SEC. 6.—The Treasurer, Secretary and Executive Committee shall make written reports at each meeting, which reports, upon their acceptance, shall be spread upon the records of the Association.

SEC. 7.—The Executive Committee shall be the governing body of the Association. They shall meet at the call of the Chairman, from time to time, and shall report upon applications for membership, shall gather and prepare information upon topics of interest, and shall arrange for their discussion at the several meetings of the Association. Five members of the Committee shall constitute a quorum.

ARTICLE IV.

MEETINGS.

The annual meeting of this Association shall be held in February, and a Semi-Annual Meeting may be held in August of each year, at such places as the Association shall determine, and such dates as may be determined by the Executive Committee.

ARTICLE V.

DUES.

The annual dues shall be $20, payable in advance, and shall cover the calender year.

ARTICLE VI.

BALLOT.

On any question before the Association a ballot may be demanded by ten of the members present.

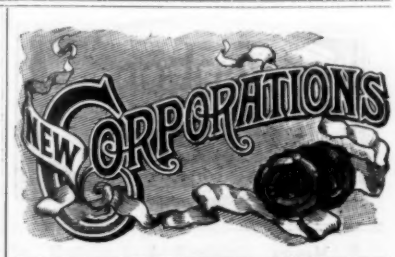
ARTICLE VII.

AMENDMENTS.

SECTION 1.—Amendments to the Constitution shall be presented in writing and referred to a Committee to be appointed by the chairman before being acted upon by the Association; a two-thirds vote of those present shall be necessary to their adoption.

SEC. 2.—No amendment shall be voted upon on the day of presentation.

The East Side Street Railway Company, of Brockton, Mass., has ordered a 135-horse power Armington & Sims engine to furnish power for its electric street cars.



Meridian, Miss.—The Thomson-Houston Electric Light and Power Company; capital stock, $15,000; E. J. O'Bierne and others, incorporators.

Spartanburg, S. C.—The Spartanburg Gas, Electric Light and Power Company, Spartanburg; capital, $30,000. A. H. Leftwich and others, incorporators.

Minneapolis, Minn.—The Minneapolis Electrical Subway Company, Minneapolis; capital, $300,000. Chas. P. Lovell and others, incorporators.

Chicago, Ill.—The Edgewater Light Company of Chicago; capital, $60,000; incorporators, John Lewis Cochran, S. Wilmar Carmel, and John C. Scovel.

Framingham, Mass—Framingham Electric Company, Ellery I. Garfield, president; Thomas T. Robinson, treasurer; capital, $60,000 in six hundred shares.

Chicago, Ill.—The Lowth Stetho Telephone Company of Chicago; capital, $5,000,000; incorporators, James Lowth, Edwin F. Brown, Jr., and Allan C. Knapp.

Chicago, Ill.—The People's Light and Power Company of Chicago; capital, $100,000; incorporators, Charles P. H. Dose, John F. Bulmann, and Charles C. Fricke.

Olympia, W. T.—The Olympia and Gray's Harbor Electric Company of Olympia. Incorporators, Messrs. Brintnall and Campbell. The object is to build telephone and telegraph lines.

Pittsburgh, Pa.—The Homestead Light and Power Company is chartered. Capital stock, $10,000. D. R. McClure is president of the company, and among the directors are W. G. Scott and E. B. Cawthrop, of the Duquesne Electric Light Company.

Springfield, Ill.—A certificate was filed changing the name of the Niagara Falls Hydraulic Motor and Power Company, of East St. Louis, to the Niagara River Hydraulic Motor and Power Company; and decreasing its capital stock from $50,000 to $10,000.

Baltimore, Md.—A certificate of incorporation of the Wenstrom Southern Electric Manufacturing Company was also filed for record, with Robert Rennert, John S. Crowthers, Edwin L. Tunis, Benjamin Blum and Joseph B. de Lery as incorporators. The capital stock is $100,000.

Baker City, Cal.—The Baker City Gas and Electric Light Company. Incorporators, J. H. Parker, J. P. Faull, J. W. Wisdom, and others. The object of the company is erecting, operating a system of gas and electric light works in Baker City. Capital stock, $50,000, in shares of $50 each.

Detroit, Mich.—The Fisher Electric Motor Company, has been incorporated with a capital stock of $100,000, half paid in. The stockholders are Hugh McMillan, William A. Jackson, Frank E. Fisher, Frederick A. Forbes, Frank E. Smith, Gilbert A. McMillan, George H. Lothrop, and Edwin B. Hutchinson. The purpose of the company is to manufacture electric motors and appliances.

Portland, Me.—The United Manufacturing Company, of Portland; capital stock, $50,000; amount paid in, $125; par value of shares, $25. The stockholders are Walter Mott, Boston, Mass.; David W. Murdock, Fort Edward, N. Y., and others. The purposes of the corporation are to manufacture, buy, sell any and all kinds of machinery and metal work, also for the purpose of buying and developing patents.

Portland, Me.—The Tilton Manufacturing Company, capital stock, $500,000; amount paid in, $400; par value of shares, $100. Elliott G. Thorp and Fred G. Tilton, Boston, Mass.; Orestes T. Doe, Parsonsfield, Maine, and W. J. Knowlton, Portland, Maine. Elliott G. Thorp, President; Fred G. Tilton, Treasurer. The purposes of the corporation are manufacturing and selling all kinds of inventions and patents.

*** Messrs. Brintnall & Campbell, of Olympia, W. T., will build a telephone line between Gray's Harbor and Olympia.

*** Mr. Geo. C. Drury has resigned from the management of the Electric Time Company of Nashville, Tenn.

*** The Western Union Company is now putting a line of wire along the Detroit, Bay City & Alpena railway, thus giving additional and much needed telegraph facilities along the Lake Huron shore.

*** Great are the wonders of the telephone. A physician reports that he was saved a two-mile ride through a driving storm one night by having the patent, a child, brought to the instrument and held there until it coughed. He diagnosed false croup, prescribed therefor, and turned in for an undisturbed sleep during the remainder of the night. He found the patient in the morning doing nicely.

*** The statement of the output of telephones by the American Bell Company for the month ended Aug. 20, and the fiscal year to date is as follows:

Increase—	1888.	1887.	Increase.
Gross output	3,694	3,533	161
Instruments returned	1,760	3,353	1,513
Net output	1,934	180	1,754
Dec. 21 to Aug. 20—			
Gross output	37,740	36,541	1,199
Instruments returned	14,646	17,663	*3,017
Net output	23,094	18,878	4,216

* Decrease.

Making the Telephone Useful.

The use of the telephone in London has, so far, says the *Financial News*, been confined almost entirely to business men. To the average housewife it remains a scientific instrument, the arcana of which she knows nothing. The United Telephone Company, rousing itself from its slumbers, has taken the problem up. The result is the establishment of what we hope will only be the first of a series of district or domestic exchanges. Kensington has been chosen as the locality for the first experiment, and the area includes the whole of Kensington proper, Earl's Court, Brompton, Chelsea, Knightsbridge, and part of Notting Hill. The idea of a "domestic" exchange is that the doctors, tradespeople and others with whom it is desirable to be in close communication in a private house are generally within a comparatively limited area. Thus it is possible, without touching upon the whole district covered by the London telephone system, to give valuable facilities to residents in a particular neighborhood at a comparatively cheap rate. The rent of a telephone connected with the Kensington Exchange will be £10 a year, which is not excessive.

The services to be performed for this payment are considerable. Of course, the value of the local exchange will depend wholly upon the number of persons who take the benefit of what it offers. But, even as it is, a subscriber starts very well, for there are 140 telephone wires belonging to the Metropolitan system which run into the Kensington Exchange, and with these the £10 subscribers are entitled to connect. With the prospectus of the local exchange is printed a classified list of these subscribers, showing that already many of the best-known tradespeople in Kensington and round about may be called up by a £10 subscriber. A local subscriber may speak to the Irish Exhibition or to the Attorney-General, to the Alexandria Hotel, or to Fulham Union, to the Siamese Legation or the Italian Exhibition, to the Duc d'Aumale or Mr. W. S. Gilbert. Then the fire and police stations and cabstands are to be at the command of the district subscribers, who are also entitled to be put on to the local telegraph offices for the transmission by telephone of telegraph messages under the usual conditions. Thus, to start with, the facilities at the disposal of the possessor of a Kensington local telephone are considerable, and their value must increase with the addition of every new subscriber.

The only point in connection with this experiment which is distinctly open to criticism is the rate charged to local subscribers for conversation with a member of the metropolitan system. Sixpence for three minutes is an excessive charge. In the provincial exchanges threepence enables a non-subscriber to talk for three minutes, and where a man is already paying £10 a year to the United Telephone Company sixpence is too much to charge for a temporary extension of his privilege. Representations to that effect have already been made, and no doubt will receive consideration. The prospectus mentions that "should any subsriber, after a trial of the local exchange, desire to commute this fee payment, he can do so on a further payment of £10, making £20 per annum, and so have the full benefit of the London metropolitan exchange system." Surely some provision should have been expressly made for the case of city subscribers whose houses may be within the area of the local exchange, and who may wish to be able to speak between their offices and residences. There is an existing arrangement, we believe, which makes a reduction on the second rent, and it would be only fair to put in force a similar arrangement for the benefit of those who might for business purposes be £20 subscribers and for domestic reasons £10 renters. If these two suggestions be taken into consideration at Oxford Court, no doubt the certain popularity of the Kensington Exchange would be enhanced and still further assured. One strong point in favor of the scheme is that the local exchange is to be open day and night, Sundays and holidays included; which, as doctors, cabs, or firemen may be required at any moment, is of no little importance.

Telegram Stealing.

As every great invention has its disadvantages, however trifling, so the telephone has its drawbacks. The telephone is so acute of hearing that before it every secrecy of telegraphing disappears. If formerly it was desired to ascertain the secrets of the telegraph wire, the latter had to be cut, and an apparatus inserted. Now, with the help of the telephone, all telegrams may be read unobservedly, even from a great distance. It is only necessary to carry a telegraph wire of moderate length parallel to the original line, and insert it in a telephone, from which the Morse signs may be read off by the ear. This would be very awkward in the case of war telegrams. Even guarding the line would be of no use, for the enemy, might, at a distance, perhaps, of half a mile from the telegraph line, where he could not be seen, secretely set up his intercepting apparatus, consisting of 100 yards of parallel wire and a telephone. How is this difficulty to be overcome? The question is solved in a surprisingly simple manner by Herr Heinrich Discher, who, in the Elektrotechniker, proposes cross telegraphing. If telegrams are sent from opposite directions on the same wire at the same time, the listener at the telephone only hears a potpourri of confused sounds. In practice, the matter may be solved in this way. One station sends actual telegrams, the other a dispatch previously agreed on. As long as the operator at the former station sees this dispatch coming in, he may be sure that no eaves-dropper reads the telegrams he is sending. The Austrian war office is said to have paid great attention to the matter lately.

——The Sprague Electrical Motor Company has motors in use in 128 different industries. In mining their motors are used for air compressors, hoists, pumps, hauling on tramways, etc. In one of the California mines some of the motors are fourteen miles away from the generating dynamos. The making of motors for stationary work by the Sprague Company has been less talked about than the same company's achievements in making motors for railways, but it is a very prosperous and growing business.

Electrical Education.

By Edwin Ruthven Weeks before the Electric Light Convention, August 30th.

The signs of the times point to a growing interest in electrical education. In the rapid development of the applications of electricity, the demand for skilled workmen far exceeds the supply, and both employers and employés are beginning to realize that the men at hand must be assisted to a mental culture, whose lack is one of the drawbacks to perfect service.

In response to a few remarks made on this subject at the Boston Convention, I have received so many letters of inquiry as to the ways and means of acquiring knowledge which will be of practical value to the workman, that it may be profitable to outline a plan that has proved its working value to employés of all grades of educational advancement, the greater number of whom, however, had previously had so little commerce with books as to be almost helpless before a small library.

When the full measure of the utility of electricity has been reached and when schools have had time to understand the needs of electrical engineering, the work of the college will afford all that preparation that theory can give. Already good courses in this line of investigation have been added to the curricula of many universities. With this branch of the subject we are not at present concerned. But it may be said in passing that the practical work in the factories, which is intended to supplement the college course, is not sufficient to make a man an electrical engineer. So great has been the demand for "expert" service, that many new fledged bachelors of science have been rushed through factories and sent out to do work requiring *manual dexterity* and an *intimate practical knowledge* of the operation of apparatus under widely varying conditions. Before the student enters the factory he should have taken his degree and should have spent at least a year at central station work where he may learn to use his hands and may become familiar with many varieties of trouble and gain an experience which will render the factory course of greater value to him. However, our immediate concern is how to help the army of raw recruits that the youth and rapid growth of our industry necessitates—to most quickly acquire an intelligent, practical, working knowledge of the service.

The mutual improvement society organized among the employés of the Kansas City Electric Light Company has learned numerous lessons in regard to proper methods, useful books and the use of them, and in order to open the discussion on this phase of electrical education, I have consented to outline the work of that society. In 1885, the company provided a commodious reading room and a large audience room fitted with a library, paper files, black boards, tables, writing materials, etc. Some half dozen electrical papers and magazines are here on file and the library now contains over one hundred volumes.

Twenty-five of these volumes, chosen with an eye to simplicity, served as a nucleus to which additions have from time to time been made. The selection of books for first use was an important work, as many texts are gotten up in a style and nomenclature, entirely beyond the taste and reading ability of the ordinary dynamo, lamp and line man. The officers of the company made it a point to talk with the men on various subjects treated in the periodicals and books, and to call attention to articles that might be helpful. Other things being equal, those who showed, in their conversation, that they had been studying, were first promoted. The librarian has kept a record of the books taken out, which shows that next to the unabridged dictionary, the one in greatest demand has been "Electricity in the Service of Man," by Dr. Alfred Ritter Von Urbanitzky. Almost every member of the society has read it and some several times. Next in popularity stand "Elementary Lessons in Electricity and Magnetism," by Thompson; the works of Gorden, Holmes and DuMoncel on "Practical Electric Lighting" and "Electricity, Its Theory, Sources and Applications," by Sprague. Several copies of each of these works had finally to be provided to meet the frequent calls. Men in all branches of the service read them and find that their perusal results in great benefit.

A recent addition to the library, F. M. Kimball's, "The Dynamo—How it is made, and How to Use It," whose simplicity and brevity will commend it to every workman, bids fair to become the most popular book with beginners. "Short Lectures to Electrical Artisans," by Fleming; "Elementary Treatise on Electric Batteries," by Niaudet; Hospitalier's "Domestic Electricity;" Brennan's Electricy and its Discoverers;" and Jean's "Lives of Electricians." "The Electric Motor and its applications," by Martin and Wetzler; "Electrical Measurement and Galvanometer," by Lockwood; "Day's Electric Light Arithmetic;" Dynamo Electric Machines," by Thompson; and Pray's "Twenty Years with the Indicator," are also favorite works.

The more purely theoretical treatises are taken out by few, but the number of their readers is gradually increasing. Among the more recent publications there is one book deserving special mention. It is Mr. Herring's "Principles of Dynamo Electric Machines," which for clearness, accuracy and subject matter should be in the hands of electrical readers of all classes.

The success of the reading-room soon led to the organization of the Gramme Society, and the work of its members shows that the men are learning how to read. There was, at first, a little opposition to it among the men, some of whom objected to giving away the information they had gained by hard knocks against experience. But this feeling has gradually died out and all have come to realize that, in words of one of our linemen, "This is a case where one can give away his cake and eat it too." An additional inducement to membership was offered by establishing a relief fund in the Society, to which each member subscribes at least twenty-five cents a month, the aggregate monthly subscription being doubled by the company. In case of sickness or disability of any member, he receives his pro rata share of the fund, and more should the society so decree. So that now, although the membership is not compulsory, most of the men in the service of the company have joined.

The meetings were formerly held on Sunday afternoon, but Tuesday evening was finally selected as a better time. The organization is of the simplest, and there is no membership fee. The officers are elected annually, and a committee appointed by the chair chooses the subjects and leaders of discussion under the advice of the general manager, who endeavors to so direct the whole work that a reading of current electrical literature shall be necessary to the intelligent hearing of the various talks. Care is taken to assign each topic to those who have had the most practical experience in regard to it. Among the subjects already considered are "A talk on Magnets," "Early History and Sources of Electricity," "The New Light;" "Technical Terms," "Electrical Units," "Ohm's Law," "Shunts," "The Arc Lamp," "The Incandescent Lamp," "Carbons," "Construction and Maintenance of Lines," "Danger from Shocks," "Grounds, Crosses and Short Circuits," "Lubrication and the Proper Care of Journals," "Various Types of Dynamo Electric Machines," "The Edison and Thomson-Houston Machines—Their Construction and Proper Care," and "The Alternating Current System." The discussions of some of these subjects required several meetings. In addition to the working topics, a biographical sketch of some noted scientists, especially an electrician, is given and is found to awaken a deeper interest in electrical study. The discussion of the subjects is both theoretical and practical, and the speakers have been led to a free use of the black board for synopsis, diagrams and illustrations.

The beginnings of the work were rather disheartening, and it required a great deal of enthusiasm and patience on the part of its inaugurators, to induce the men to take any useful part in the exercises. It was only by continual questionings and references to books and periodicals, by pointing out the advantage to be derived from the perusal of this or that article in this or that paper or book, the constant recognition of the good work of each speaker, and the ignoring of the weak and useless, that the men were gradually encouraged to take hold of the subjects in a free and easy way, and to give up the cream of their experience without fear of losing it.

But the results have amply repaid all efforts and the growing interest of the members, their anxiety for perfect equipment, and above all their ready expression of the advantage which the necessary reading and the interchange of thought have been to them, are most gratifying proofs of the wisdom of the movement.

Those members of the society whose information lay chiefly in a practical direction, have added to that information, and have gained a knowledge of some of the principles underlying our industry. They are thus deriving more pleasure from their work and are on the way to a higher and wider field of usefulness. Those whose information was mostly of a theoretical nature have clinched such information and have acquired a more intimate knowledge of the apparatus used, and are thus better prepared to discharge the duties devolving upon them.

The benefits of this work to the company are evident in the improved condition of all parts of the service, and in the interest which the employés take in perfecting it—an interest which has grown out of the dawning perception that the company has at heart the good of its workmen, as well as the increase of its dividends.

The Electric Road at Salem.

The six cars upon the Naumkeag road at Salem, equipped by the Sprague Co., have now been running about a month and have been giving perfect satisfaction. The cost of running these cars by electricity is only about 40 per cent. of the cost of operating the same number of cars by horses.

To obviate all noise from the motors during the run, the Sprague Co. has adopted a very ingenious method, using a novel wood fibre substance in the gearing, making the operation of the motors absolutely noiseless. This fibre by a peculiar process, though it is a compound entirely of wood, is rendered as hard as steel. The cars are equipped with lightning arresters as are all the cars which the Sprague Co. have ever put in operation. In winter for clearing snow and ice from the rails, Mr. Sprague has devised what is called a "working car." This car is fully equipped with plow, ice cutter, sand and salt arrangements, etc., and is driven by a powerful 40 h. p. Sprague motor. In front of the car is a revolving wheel which breaks up the snow crust, and behind a revolving brush that sweeps the rails clean. In Carbondale, Pa., the car has worked with entire success. In Richmond there were two or three bad sleet storms last winter, but by putting a man on top of the car and knocking the contact wire with a short pole the ice was easily cleared from it, and with the overhead current all right, the regular line cars ran easily. The total length of the line is one mile and three quarters. Altogether there have been set 175 wooden and 14 iron poles. The amount of wire used has been nine miles, including contact, main, feed, ground and span wire. The amount of line wire, that is, main wire, contact, ground and feed wire is seven miles. The electric cars make regular 15 minute trips to the Willows, and have carried heavy freights. One car recently took 110 passengers easily up over the steep grade at Fort Lee, a long hill which has frequently compelled even three horses to succomb. It is said that the Naumkeag Co. will extend this road to Beverly, using the electrical system.

The Isabella Furnace Company, Etna, Pa., have recently increased their Brush Electric Light plant by purchasing a number of arc lamps from the Brush Electric Company, Cleveland, Ohio.

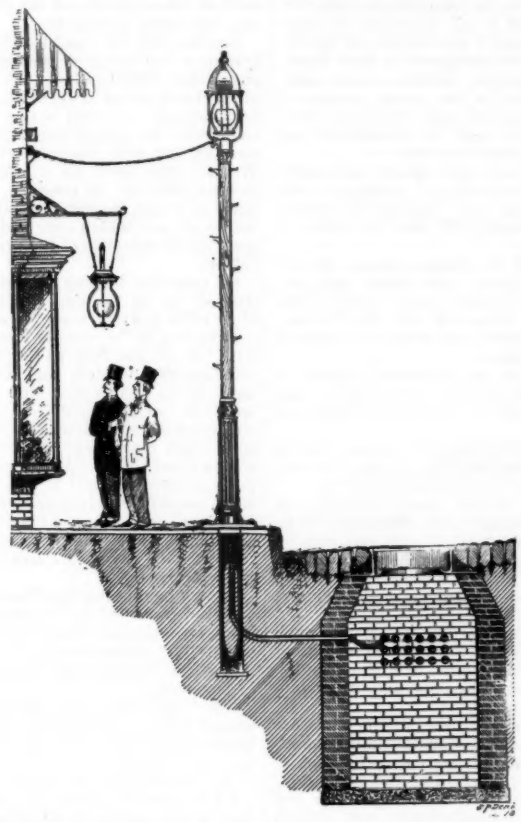
"Overhead and Underground Wires in New York."

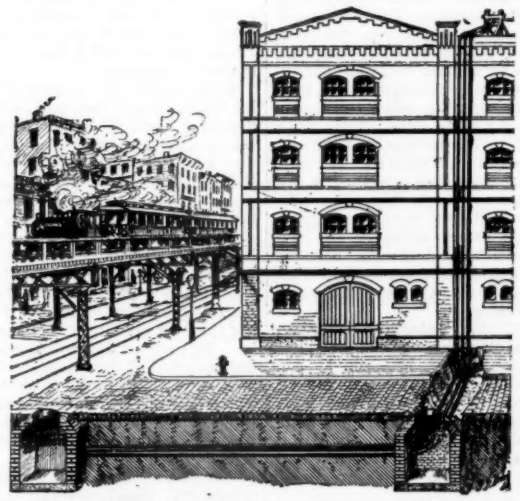
PAPER READ BY DR. S. S. WHEELER, BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, AUGUST 30TH.

Mr. Chairman, and Gentlemen of the Convention:

It is my purpose, in as brief and concise a manner as possible, to give you some idea of the condition of the overhead and underground wires in the City of New York, and the means which are being adopted by the public authorities to bring about a better state of affairs than the one now and for some time existing.

In 1884, the Legislature of the State of New York enacted a law to the effect that electrical companies in the City of New York and Brooklyn should place their conductors underground. The local authorities were expected to enforce this law, and the maintenance of electrical conductors overhead in these two cities, after a certain day, was declared to be unlawful.





ILLUSTRATING METHOD OF DISTRIBUTION OF ELECTRIC WIRES SUGGESTED BY MR. WHEELER.

Of course, the business of telephoning, telegraphing, and electric lighting could not be disposed of so summarily, and before the day appointed upon which the maintenance of wires overhead was to become unlawful fell due, the legislature enacted, in 1885, a law for the establishment and organization of a commission, the purpose and object of which was to provide a plan by which electrical conductors in the cities of New York and Brooklyn could be placed underground without interfering with the efficiency of the electrical service. By this law of 1885 it was provided that companies could submit to the commissions established in the twin cities, plans for placing their conductors underground, and should the said plans meet the approval of the commissioners, the companies submitting them could thereupon proceed to place their conductors underground according to these approved methods.

In 1885 the question of placing electrical conductors under ground was very generally disputed, and no company submitted plans to the Commission within the required time. It thereupon became the duty of the Commissioners of the Electrical Subways to devise a method by which electrical conductors could be placed underground, and to compel companies to carry out the work according to this method.

The subject was then comparatively new, the difficulty not fairly comprehended, and the different kinds of service, as well as the ways in which the wires might be put underground, were not even classified.

The result of the investigation made by the Commission to ascertain by what method wires could best be placed underground in cities, was that the Commission had to listen to about four hundred and fifty plans, many of them having nothing to do with the work to be accomplished, and many of them utterly absurd.

Notwithstanding the impression that underground wires were a common thing in other cities, especially abroad, nothing had been done that would serve as experience for this city. In many places wires had been laid underground singly, in pipes, in sewers, and in cables, but no such piecemeal plan could be allowed in a city having more telephones, more telegraphs, more electric light and less available area, than any other spot in the world in proportion to the amount of business going on.

To be of any value, under such circumstances, a plan had to be found which would permit new wires being put in from time to time, almost without limit, without disturbing the pavements of streets, and of sufficient capacity to accommodate the large number of wires, for which a sufficient space underground could scarcely be found between the various constructions already buried.

The difficulty of the problem, and the reason why the experience of other places are of so little value to us, will be seen when it is considered that the number of wires in a given space in New York, taking the average, is very much greater than in any other center in the world.

The places between which these wires run, instead of being in an approximately circular area, is in the case of the three other leading electrical cities, are drawn out on a long and very narrow island, thus crowding the conductors together and increasing their length between points. In addition to the difficulty of a much greater amount of wire and less area to contain it, there is the great difference in rapidity of business, which makes it necessary to be able to put up and remove wires and instruments here more speedily than in the older cities.

The ground was so filled with gas, water and steam pipes, sewer and pneumatic dispatch tubes, and their connecting boxes and manholes, that it was impossible to find a straight course for a conduit, or even a small number of ducts; and the repairs to these, which is continually going on, would make the wires specially liable to disturbance and injury. The earth is saturated with gases from the various pipes, and this would collect in any open space, such as the subways would afford, destroying the insulation of the cables, suffocating the workmen, or causing explosions. In comparing wires with gas mains, it is sometimes said that the former are much more difficult to bury successfully than the latter, because the leakage does serious harm, while the leakage from the gas pipes is of no consequence. It is true that the loss from escaping gas does not cripple the gas companies' business at their present prices, but the gas fills the earth, gets into the electrical conduits, and there makes a very bad combination, for which electricity has to stand the whole blame. Indeed, if it were not for the gas the underground wire problem would be easier, and very much more agreeable. On the other hand, when the electric current wanders off and melts the iron of the gas pipe, electricity again has to stand the blame, and thus there is not a fair distribution of the responsibility.

In order to treat the subject thoroughly, the Board of Electrical Subways of the City of New York, investigated all the different systems in use in other cities; in connection with the many plans which were submitted for approval to be used in New York.

It was found that, in Paris, they are fortunate in having extraordinarly large sewers, through which in the streets where the sewers run all of the wires are laid together with the gas and water pipes. These sewers consist of a large arched passage with a flat floor through the centre of which runs a deep trench or canal for the sewage. The flat pavement on either side of this forms a broad walk over which the pipes and wires are suspended from the arched roof. A rail is laid on either side of the canal, and on the track so formed a car can travel carrying a drag which is used in cleaning the canal or sewer proper. In the streets which do not have these sewers the wires are strung upon the housetops.

The only other place which at that time furnished experience at all applicable to the problem here was London. But here there were, and are now practically, no arc lights at all, and therefore no circuits; there are extremely few incandescents, with no outdoor circuits; the telephone is not used very extensively, and the wires of the telegraph are placed under ground by the government. The plan employed is what might be called the handhole drawing in system, and consists of five-inch cast-iron pipes laid under the sidewalks and accessible through handholes or "flush boxes." These pipes are said (I do not know how correctly) to be loosely jointed for the purpose of admitting water to preserve the cables which are of gutta percha, the same as is used for submarine cables, and which deteriorate very rapidly when exposed to the air. In other words, they have learned, by their experience with ocean cables, how to make insulation which will stand the water, so they try to convert the subway problem into the same kind of work. Conduits have been laid at a later date in other places.

In Brooklyn there are about ten miles of Dorset conduit, and about four and a half miles of a conduit consisting of a wooden box made of creosoted boards loosely put together, with narrower ones slid into grooves on the inside to form partitions. This duct being loose and unstable simply affords a means of keeping cables from touching each other and keeping them in place; and as creosote will dissolve rubber, it is not a good place in which to put a rubber cable.

Another plan which has seen some slight use in Philadelphia is the Johnstone system. This consists of a broad flat cast iron duct, made in sections, about six feet long, and divided horizontally into an upper and a lower half or shell, so that a section can be removed and another substituted without cutting the wires already drawn into place. The duct is divided into a number of smaller ducts, for classifying the wires, by partitions

consisting of long slabs of cast iron which are slid into place in grooves cast in the inside of the outer shell. The feature of this system is the facility which it affords of introducing an outlet from the duct exactly opposite any lamp post or desired part of a building, by taking off the upper or lower half of a single section, and putting in its place a new half section with a hole in it at the desired point, to which a branching elbow can be bolted.

This construction has been authorized for a distributing system in New York and Broadway from 14th to 34th streets, for arc lighting, etc. The work is now being prepared, and the system is therefore of some interest.

There goes with this style of conduit a man-hole formed of a bottom, a top and variable number of rings or sleeves placed one upon the other so as to build up the height of the man-hole and permit of the ducts being run out at any depth to escape pipe obstructions, etc. One of these sleeves is split up into a number of panels bolted together, any one of which can be taken off to allow the ducts to be run out on either side at any angle.

All of the other plans by which wires have been put under ground, except the Dorset and other man-hole drawing in systems used in this city, which will be described later, consist of nothing but the wire with covering buried in a trench, and are of no value beyond the taking care of their own particular wire.

Prominent among such plans may be mentioned the Edison tubes. This system, which has been extremely successful for its one kind of service, consists of heavy copper rods wound with rope, and laid in wrought iron pipes filled with an insulating compound composed of Trinidad asphaltum, resin, paraffin and linseed oil. This compound is run into the pipe when heated to about 300 degrees Fahrenheit, under considerable pressure, while an exhaust is applied to the other end for the purpose of drawing out all air bubbles. The end of the tubes are then plugged with wood soaked in paraffin, leaving the coppers projecting.

The chief peculiarity of this system of conductors, and the feature of which is, perhaps, most familar to all, is the means of connecting up these lengths of tubing and conductors. The rods are connected by short pieces of copper cable terminating in suitable copper sleeves, which are soldered to the ends of the rods when in position and the bow shaped expansion joint so formed is covered with hot compound poured into a small cast iron coupling box which is bolted on to the junction. The lines terminate at the street crossings in large cast iron boxes, like manholes, where the rods are joined by heavy copper cables, to suitable connecting device near the top.

This plan is too expensive except for very heavy conductors, but serves admirably the requirements of incandescent lighting. In the early days of the system the thin pipes were greatly damaged by picks in digging around them and by other outside disturbances. A slight blow from a pick would puncture the pipe, letting in a little water, which was liable in time to form an arc between the conductors, which would in turn burn the compound converting it into a conductor and forming a "ground" The greatest difficulty with these tubes was found to be that the insulator would be converted into carbon by the charring action of leaks at the slightest start.

Tubes of the same style as these, but containing a large cable of small wires, have been in successful use in carrying telephone wires out from the 21st street Exchange in New York.

Another method somewhat similar is the Brooks System, which consists of wires covered with cotton and drawn through large iron pipes which are afterwards filled with a heavy resin oil so as to prevent the water from entering. This oil is a good insulator.

The remaining plans are of the next lower grade of mechanical construction and consist of wires and cables of various kinds laid in troughs and covered with some protecting substance, usually tar or asphaltum.

Among these may be mentioned the few telephone and telegraph wires in Boston made into a cable and laid in a trough and covered with bitumen. A few telephone wires laid in New York and electric light wires in Pittsburgh laid in the same way.

There are also innumerable places where cables of various kinds are laid directly in the earth, sometimes with a board covering to protect them from men with shovels. But none of these are of special interest to us, because obviously we cannot use them.

The result of the investigations of the Commission were summed up in their Second Report, dated the 30th of June, 1886, as follows:

"The principal systems of electrical subways may be divided, first, as to their material composition; and second, as to their mechanical construction and the manner in which the wires are placed in them.

As to material composition, subways are:

1st. Of insulating material, such as wood, glass, concrete, etc.

2d. Of conducting material, such as iron.

As to mechanical construction, subways are, generally speaking:

1st. Tunnel systems.

2d. "Drawing-in" systems.

3d. Solid systems.

4th. "Dropping-in" systems.

5th. Combined systems.

Tunnel systems, or those where space is provided underground sufficient to allow the passage to and fro of men who place the wires within the subway, could be recommended, were unlimited time and money at the disposal of the Commission; but the expense of such a system and the crying need of immediate action preclude the adoption of such a plan. If ever underground railroads become a feature of our city transportation, then, perhaps, the tunnel can be used for some of the future trunk line cables.

In Paris, where the foundations of the city are honeycombed in all directions by large sewers, such a plan is practicable and admirable, but not to be thought of in New York.

Drawing-in systems, or those where manholes are provided in the streets, connected by tubes or pipes through which the wires can be drawn, are next in prominence and convenience to tunnel systems.

In Chicago, there were seen in successful operation nearly 20 miles of conduits of the "drawing in and out" pattern of various materials, containing all kinds of wires, as follows:

Eight miles of the Dorset system of concrete conduit divided into ducts, and containing in the separate ducts wires of the city telephone, telegraph and fire service, electric light wires, and wires of different telegraph companies.

Four miles of the Johnstone system of iron conduit divided by metal shelves, and carrying the wires of the Postal Telegraph Company.

One mile of three-inch iron pipes, four in number, carrying the wires of the Western Union Telegraph Company.

Three miles of iron pipes, carrying the wires of the Bankers and Merchants Telegraph Company.

In Philadelphia, a comprehensive "drawing-in" system of iron was seen, containing electric light and telephone and telegraph wires.

In Boston, some two miles of such "drawing-in" iron systems are in operation.

In London, 9,000 miles of wire are underground, bunched into cables, and drawn into three-inch iron pipes.

Solid Systems, or those where wires are permanently imbedded in insulating material and incapable of being reached except by tearing up the streets and the insulation, have been found to work, with more or less success. The Commissioners saw several miles of this conduit in successful operation in Chicago by the telephone company there, where wires were buried in an asphalt or coal-tar cement, laid in a wooden trough.

Several miles of similar conduit are in use in Washington for electric lighting, and there are other instances of the successful operation of this description of conduit.

In this city of New York there are several systems in use underground, each more or less satisfactory to those employing it.

A prominent example is the Brooks system used by the Metropolitan Telephone and Telegraph Company. It consists of an iron tube in which cotton-wrapped wires are drawn, and the tube filled with oil, the oil acting as an insulating medium. It is kept at a desired pressure, the tubes constantly full, by means of a stand-pipe. They use a two and a half inch iron pipe, and the system is cheap, costing less than $11 per mile of wire, because into such a pipe they can draw 300 telephone wires. Wires for telephone purposes, and those used in the American District and other call-boxes, are of a very light intensity, and do not need as heavy insulation as do all other kinds. This system is claimed to give perfect satisfaction for telephone conductors.

The Western Union Telegraph Company has many wires already down in this city, laid in 3-inch iron pipes, into which they draw cables manufactured from okonite or kerite insulation. These pipes are lead-jointed, are laid in Broadway, and have man-holes occasionally for taking out the wires.

To sum up as to the form of subway and the manner in which the wires are to be placed in it:

We are convinced that from the standpoint of an electrician, simply it may be said, that almost any plan of system can be made to work; from a single lead-covered wire laid directly in the earth; to a great tunnel upon whose walls the insulated conductors can be hung. Within certain broad limits, any system is electrically practicable; retardation and induction can be overcome. It is only when we face in this city the mechanical engineering and chemical questions of interference with water-pipes, gas-pipes and sewer-pipes, of obstructions from vaults, or danger from steam pipes, of the action of sewer and illuminating gas, that the necessity for careful discrimination presents itself.

In the future, when the uses of electricity become more general, and its nature better known, it may be that the City of New York will absolutely require a grand electrical underground highway, where space can be provided for the conducting and distributing of sufficient power to run all the engines and work all the machinery within the city limits. It may be, and probably will be, that before such space is needed, much more will be known of the qualities of different forms of electrical conductors, and of the best method of carrying them underground, and that the matter of electrical subways will be no longer experimental, but practically demonstrated in every detail.

When such a time comes the Commission, or other authority, will determine what is required to meet the necessities of the occasion.

The responsibilities of the present Commission begin and end with providing for the requirements of their own day, and for such of the exigencies of the future as they can reasonably anticipate.

Leaving out of consideration all tunnel systems as too expensive, we must also discard any system which calls for the simple laying of insulated cables in the earth. They would not stand the chemical action of the gases and acids; the streets would be continually torn up for new connections and repairs. We are thus shut up to the question of electric subways or conduits, in which the wires or cables, insulated or otherwise, must be placed, and which once laid down should meet all the demands of the present and near future.

Of conduits it may be safely predicted that, so far as the experience of this and other cities is a test, some form or other of a "drawing in" system is most convenient. The life of the best cable is by no means satisfactorily decided, and, of any particular cable, to predict how long it would last, would be purely speculative. Of wires not contained in cables it may be said that they are equally more uncertain in their length of life and usefulness. At all events for purposes of distribution it is desirable that the wires should be easily approached at frequent intervals, and the Commission cannot countenance any plan that looks to the disturbance of pavements more than is absolutely necessary.

It may be that through lines of wire could be better protected laid in permanent beds of insulating material; but a "drawing-in" conduit system allows space to be provided for new wires without the frequent tearing up of pavements.

The Commission can, therefore, give their approval to a "drawing-in" system with frequent man-holes, as the general form of subway best adapted to meet the requirements of the electrical service of the present.

Up to this time it was the general impression, which had not been contradicted by experience, because there was none, that the conduits must be built of a non-conducting substance, and not of metal, because the latter would be liable to chafe through the insulation on the wire and cause a ground, and because the companies using the more delicate currents—particularly the Telephone Company, declared positively that the presence of a large mass of surrounding metal would interfere by induction with the working of their wires.

The best known plan at this time for building ducts of insulating material, and without the use of metallic tubes, was the Dorset system, which had been laid to some extent in Chicago.

This consists of a bundle of parallel tubular ducts about two and a half inches in diameter, built of blocks formed of a combination of coal tar, pitch and fine gravel, cast with tubular openings running through them from end to end. These blocks were placed together, end to end, with the holes in line so as to form continuous tubes or passages, and were cemented together by pouring a mastic softer than was used in making the blocks into the cracks between them. The blocks were made to adhere to this by warming their ends with hot irons and allowing them to cool after this mastic is poured in. To prevent the melted mastic from closing the ends of the passages, tubular pieces of metal or paper were inserted in the ducts at the ends of the blocks, making a sort of internal sleeve coupling. The conduits so formed terminate in brick man-holes at the street crossings.

The objections to this material, as it was afterwards found, are that it is brittle, porous, requires care in laying, and having no elasticity, cracks with changes of temperature, so that it is not likely to be made water-tight with average workmanship.

But a conduit was accordingly laid in New York upon this plan, on Sixth avenue, from Twenty-third to Fifty-eighth streets, a distance of 1.6 miles. And the objections were then found, as far as arc circuits were concerned, that its numerous joints were liable to open, and it might leak as mentioned above.

The next plan proposed for New York was to use a somewhat similar mixture without requiring it to be made so hard, with the object of preventing its cracking, and to preserve the openings or ducts by casting this bituminous mastic or mixture of bitumen and sand around long pasteboard tubes. But no tubes could be found which would not absorb moisture, and the heat of the mastic caused the ones tried to swell up and disintegrate. The manufacturers of indurated fibre wares were confident that satisfactory tubes could be produced, but it required special machinery and a long time for experiments. Tin and sheet iron linings were then suggested, but objected to on account of the difficulty of making good joints. Zinc, however, was considered unobjectionable, and an experimental tube of the Averil system, consisting of soldered zinc tubes in bituminous mastic was laid in the yard of one of the manufacturers, but it was found that the heat of the mastic melted the solder of the tubes. This difficulty was met by substituting a lap or fold-over seam, and then it was found that the heat of the mastic also affected the nature of the zinc, impaired its durability. On account of the certainty of the zinc tubing rusting and finally crumbling away it was next thought best to insure the permanence of the bore of the ducts by substituting for the soft mastic some substance which would set, after being poured in, and become hard and durable. For this purpose a hydraulic cement concrete filling was substituted for the mastic. And then a line was laid in Fifty-eighth street. In laying, the thin zinc tubing was found very frail, liable to be dented in handling, and therefore undesirable. But the idea of the concrete was that it would maintain a hard, solid, smooth bore even after the thin sheet metal lining had rusted out.

After a thorough investigation and discussion of all the different materials, and the advantages and disadvantages of each, it was finally concluded that a conduit or subway for electrical conductors underground is merely a mechanical protection for the wires to be placed therein, and should afford the very best protection possible to be procured while the electrical protection or insulation may be safely left to the manufacturers of cable and and wires to be placed in subways.

It was decided that the use of metallic tubes would not seriously interfere, by induction, with the working of the wires, and were to be preferred because the continuous conducting shield so formed will carry off any escaping current and prevent damage to other cables. Accordingly conduits of iron gas pipe imbedded in concrete were put down, and these seem to be about the best kind so far constructed. They are best, first because there are plenty of workmen who understand gas-pipe fitting and laying concrete, and because they are durable and entirely non-combustible. The purpose of the cement is to prevent the iron from rusting, which it does very effectually. If, in time, the pipes are destroyed by rusting from the inside, the solid hydraulic cement concrete will remain, furnishing a permanent duct with a hard smooth bore.

The man-holes used in connection with these various kinds of ducts have nearly all been built of brick laid in hydraulic cement, and capped with an iron casting to form a seat for the water-tight lid. The lids are usually bolted down upon a rubber gasket, but unlike the Edison man-holes, instead of being held by a single thrusting screw which, passing through a cross-bar presses down upon the centre of the cover. Some of the lids have been made funnel-shaped so as to cause water to drain away from the edge collect in the centre. By this means the liability to leakage at the gasket is diminished, because there is less chance of water standing over the joint. The facility of opening the man-holes afforded by this method of fastening the lid with a single screw is of great value in reducing the labor and time required to open and close a line of conduit when laying a wire, and is a material advance in the solution of the problem.

In regard to moisture in the conduits. In the iron tube plan, which is the best, there is of course no leakage, because the tubes themselves are water-tight, could even be made air tight, and because they are covered with cement which is in itself water-tight. The man-holes are made of water-tight materials, and there should be no leakage under the lid. Lookers on find that a great many of the man-holes have a great deal of water standing in them, this is simply because the lids are not fastened down, but simply laid in place by the builders, often without any gasket, and the man-holes fill with rain and stay full until cleaned out for use. When cleaned and closed properly they appear not to receive any water by leakage. To satisfy myself of this I had an ordinary brick man-hole which had been thoroughly cleaned and dried by letting the sun shine in on a bright day, marked on the inside with lime all the way round under the cover and then closed. This marking was to show whether any water came through the joint of the cover, in which case it would have run down over the lime mark, and discolored it, or whether it soaked in through the bottom or sides. But after a rain fall sufficiently heavy to test the leakage, the hole was opened and found perfectly dry and the lime undisturbed. This proved that there was neither leakage through the brickwork or under the cover.

There is, however, another source of moisture which is hard to overcome. The

condensation of vapor from the air which the man-hole and ducts contain. Every time a hole is opened it refills itself with warm air, containing more moisture than it can keep when cooled down to the temperature of the masonry, consequently as soon as the lid is screwed down this fresh air deposits a dew on the inside of the man-hole. As it is impossible to open and dry out a man-hole without putting in new air which will condense in turn, no amount of cleaning will overcome this difficulty. The presence of moisture tends to corrode exposed wires and therefore the question of whether it is better to protect the splices and make the insulation of the wires so that they will not be injured by this moisture, or to dry out the entire system of conduits by a system of ventilation is unsettled. But this question fortunately is one of minor importance.

The question of distribution of electrical currents from the main subways constructed in the manner I have described, has been largely left by the authorities in the city of New York to the preference of the electrical companies.

Two systems of distribution are at present actually in use in New York by the telephone company. These are known as the house-top system of distribution, an example of which may be seen at Sixth avenue and 51st street, and the man-hole system of distribution, which may be seen at Broadway and Exchange Place.

In addition to these systems, there are five modes of distribution which can be readily applied to the subways as constructed in New York, and which will be allowed in cases where they are severally most expedient, the lamp post system of distribution, the house-front system, the houses-vault system, now in use in Chicago, the back-yard system, and the man-hole system. In the heart of Chicago, the distribution question is peculiarly easy of solution, because the sidewalks were left hollow by raising the street levels after the great fire, and the wires are run through these spaces to the houses.

Having decided the question of the kind of conduit to use, the Commission proceeded to have subways constructed according to these plans. It was decided best, as a matter of expediency and to prevent accident, that electric light subways should be distinct from those intended for telephone and telegraph services, and it has therefore been the practice of the authorities in New York to build subways for one class of conductors upon one side of the street, and reserve the other side for those of other service.

The telephone people were the first to realize that underground wires were sure to be ultimately a success. Their business had grown enormously, they had about reached the capacity of their pole lines, and it was not easy to get the use of additional streets, because the streets were crowded with wires—both their own and those of other companies. It was found that the growth of the telephone business was practically put an end to by the fact that no more room could be found in which to string wires. House-owners were charging a rental of one dollar per wire per year, which, in some cases, amounted to a very large rental in the case of building, and the telephone people had reached the point of refusing subscribers. They came forward, and were the first to declare for underground wires.

After some resistance, the telegraph and electric light companies have come to the conclusion that it is as well for them to comply with the demands of the public and place the bulk of their conductors underground. And, as a matter of fact, in the City of New York, to-day, there is but one single company out of the large number doing business here which refuses absolutely to comply with the provisions of the Subway Acts, and nine-tenths of the opposition and outcry has been caused by this company.

At the present time the total construction of single duct in the City of New York amounts to four hundred and twenty miles. In these subways there are already in operation some four thousand miles of telephone and telegraph wires, and some hundreds of miles of incandescent electric light conductors. Cables for arc lighting are to be drawn in on Broadway, from Fourteenth to Thirty-fourth streets by the Brush Electric Illuminating Company within the present week. A letter from the electrician of the Metropolitan Telephone and Telegraph Company, bearing date August 25th, as estimating the exact length of cables of various kinds now underground, is as follows·

"NEW YORK, Aug. 25th, 1888.

S. S. WHEELER, ESQ.,
Electrician of the Board of Electrical Control:

Dear Sir:—I have hastily collected the following information relating to the underground mileage of wire:

The number of miles of single wire conductors in New York City of the various kinds is as follows:

Brooks system, laid May 28th, 1885, 200 miles; Patterson cable, laid March 18th, 1885, 226 miles; Edison system, laid June 20th, 1885, 194 miles; Patterson cable, laid in 1886–7, 805 miles; Patterson cable twisted in pairs, number of miles, counting both wires, in 1888, 2,272 miles.

We have in course of construction some 12,000 miles of conductors which will be laid in September and October.

Total number of miles already laid in New York, 3,697. The number of miles of underground wire in Brooklyn is 2,100; in Paris, 4,100; in Chicago, 200. As per report of telephone convention held September 26th, 1887, the number of miles of underground wire in Boston is 400; in Pittsburgh, about 1,000.

I find that there is a very small amount of underground wires used in London for telephone purposes, there being some short lengths used entering exchanges, which is not worth while considering.

Respectfully,
(Signed) J. A. SEELY, *Electrician.*

It will be seen from this that there are already underground in the city of New York, more electrical conductors than in any other city in the world, while the capacity of the construction already finished in this city may be estimated fairly at something over 30,000 miles of conductors.

There are through lines completed from the Battery to the Park on the two principal thoroughfares of this city, Broadway and Sixth avenue, and a gradual conversion of overhead systems to underground ones in the busy parts of the city may be confidently expected.

The Board of Electrical Control is not unmindful, however, of the magnitude of the labor and expense required in converting the present arrangements into underground systems, and does not contemplate either the hampering of the business of electrical companies by forcing unreasonable numbers of wires underground or by attempting to compel the use of subways faster than is consistent with the efficient use of the different electric service by the public. If the great mass of overhead conductors are removed, and the remainder of the service brought to a condition which will insure the safety of the public and, at the same time, the welfare of the companies themselves, it will be the result desired by the people of the city, and which the Board of Electrical Control is endeavoring to attain.

As to this matter of regulating the overhead service in the city, I may say that an investigation of all the wires overhead, instituted since I have been connected with the work of the authorities in charge of electrical matters here, by the inspectors appointed after a rigid examination and found competent for the purpose, has shown that a great deal of very bad and unnecessarily dangerous work has been done in New York, and that a reprehensible and inexcusable condition of overhead wires is the principal, if not the only, cause of the clamor for underground service.

In addition to this, an enormous quantity of wire and a large number of poles not in use at all exist, amounting, as has been variously estimated, to from a half to two-thirds of all the wire and poles in the city.

As I have said, a system of inspection and reports has been organized, and within a few months there have been found and reported to the owners 2,000 dead wires. A notice is sent out in every case, and at the end of a week the work is again inspected, and if nothing has been done the owner is again notified, and if the wires, poles, etc., are not necessary, a notice is also to the Bureau of Encumbrances of the Department of Public Works to remove them.

All arc lamps that are so low as to be within the road of pedestrians with an umbrella, are reported as too low. Circuits which have especially defective insulation or joints are reported as dangerous. A few cases of bad indoor work have been reported as violating the rules of the Board of Fire Underwriters, and so on. The number of complaints sent to the various companies as well as the proportion of them that receive attention by each company are shown in the detailed schedule, which indicates the position taken toward the work of inspection by the several companies, and I may say that the single opposition company of which I have already spoken, is the only one which disregards the notification of flagrant bad work, for which there is no excuse and which everyone else admits should be inspected on behalf of the public, and corrected immediately.

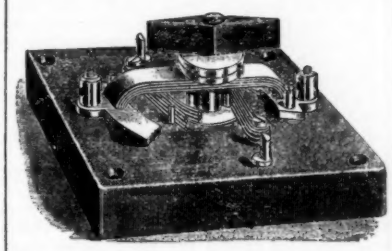
One has no idea of the aerial freebooting that is and always has been going on with overhead wires, until they spend sometime seeing what there is overhead.

The condition of wires in this city is simply outrageous. Every other kind of business, such as those which involve obstructing the sidewalks, have fallen under the supervision of some branch of the government and cleanliness and order have been insisted upon, but heretofore there had never been any supervision of outdoor wiring, and its condition corresponds to that of a city without police supervision.

The companies owning wires will not permit each other to make common use of the poles, but will chop off wires owned by others without notice. The telephone people object to the electric light wires on account of the induction. Where there is a line of light wires on their side of the street passing close to their poles they will not allow them to be made fast. The result of the necessity thus made for extra poles is sometimes, four lines of poles on one side of the street, hence most of the wires swing close to or against the other poles to which they are not attached, and linemen in climbing them have to crawl through all the other wires which are not fastened to cross arms.

Quick Break Switch for Large Currents.

A modified form of Messrs. Woodhouse and Rawson's well-known "G" switch has lately been brought out, which appears to possess many advantages. The handle and contact-brush are not rigidly fixed together, although mounted on the same center-pin; but two studs fixed in the handle-plate above the brush work in two segmental slots stamped out of a disc attached to the upper side of the brush, and these are so arranged that as the handle is turned in the "off" direction, the brush is driven by it nearly to the edge of the terminal contact-plates, when it is taken charge of by two sets of springs which effect a very rapid and complete break. These sets of springs each consist of several springs of steel wire formed up into "lockspring" shape, and all mounted on one stud, the free ends bearing against a pin on the under side of brush. The plates of vulcanized fibre, which, in the older form



of "G" switch, were fitted up for the brush to rest on when off the contact-plates are here done away with, so that the brush flies off the contact-plates quite clear of everything, and well above the slate base on which all the work is mounted. The necessary pressure between the brush and contact-plates is produced by a triangular spring washer in a recess underneath the slate base, which draws down the centre pin carrying the brush. The combination of the contact-brush of thin plates, the spring washer underneath, and the two sets of multiple springs, produce a particulary "sweet" motion; and the contacts made by the brush are evidently as perfect as can be desired. The good character of the free and quick break is also due to the combined effects of the very flexible springs and the spring washer underneath.

They state that these switches are made to carry 5, 10, 20, 30, 60 and 100 amperes, the three smaller sizes being rather different in construction from the others; and that very shortly switches on this design, to carry considerably larger currents, will be in the market.

We may add that these quick-break "G" switches are, like the older pattern, strongly made, and amply large enough for the currents they are intended to carry.—*The Electrical Engineer, London.*

—— The American Optical Company's Works, Southbridge, Mass., will be illuminated by electric lights.

—— The Charlestown Gas Company, Charlestown, Mass., have recently increased their electric light plant by the purchase of a number of double arc lamps from the Brush Electric Company, Cleveland, Ohio. They now have in use several Brush dynamos, 30 light capacity each, and several hundred 2,000 candle-power Brush arc lamps.

—— The Binghamton Gas and Electric Company, of Binghamton, N. Y., are increasing their electric light plant. They have ordered from the Brush Electric Company, Cleveland, Ohio, one 65 arc light 2,000 c. p. dynamo and arc lamps. This Company is now burning some 200 arc and 300 or 400 incandescent lights of the Brush system.

ELECTRIC LIGHT NEWS

—— The Denver, Col., Electric Illuminating Company will erect a 1½-story brick building.

—— The Hardland Mills, New Bedford, Mass., is introducing electric light. Five hundred lights are being put in.

—— The Charleston, S. C., Electric Light Company is contemplating the erection of a plant on Sullivan's Island.

—— The arc light in Saccarappa, Me., have been started up, but the people complain that they are too few and far between.

—— The Porter Manufacturing Company are building two 125-horse power boilers for the Auburn, N. Y., Electric Light Company.

—— The Thomson-Houston Electric Light Company, of San Francisco, has sold a 50 light plant to the Electric Light Company of Portland, Or.

—— The Schuyler Electric Light Company, Newark, N. J., will erect a two-story brick building in order to give better accommodation to their growing business.

—— The Electric Light and Gas Company of Columbia S. C., has purchased an automatic engine for the Thomson-Houston Electric Light Company of Macon, Ga.

—— The electric light plant at Los Angelos is being enlarged at a cost of $30,000. Two large Hazelton tripod boilers and engines, 500 horse-power, arebeing put in.

—— The New Bedford, Mass., Gas Light Company to-day voted to increase the capital stock, $50,000, making it $300,000, to allow for increase of plant for electric lighting.

—— The Thomson-Houston Electric Company of Lynn, Mass., has purchased the Otis Johnson property on Federal street. A building is to be put up at once to enlarge the works of the company.

—— S. and J. C. Atlee, of Fort Madison, Ia., have recently increased their electric light plant plant by purchasing from the Brush Electric Company, of Cleveland, O., a 45 light, 1,200 c.p. dynamo.

—— The new shops of the Pennsylvania Railroad Company, East Camden, N. J., will be lighted with 450 incandescent electric lamps, supplied by two Brush dynamos. The yards will be illuminated with arc lights.

—— The Sprague Electric Railway and Motor Company, Boston, Mass., has already begun to prepare the equipment for the cars which will run on Beacon street, Brookline. President Whitney expects to have the road in operation by Oct. 1.

—— The electric street light on the Kingston road, Narragansett Pier, R. I., located in front of Metataxet Hotel, was turned on for the first time last week. Landlord Caswell celebrated the occasion by a concert by the Narragansett cornet band.

—— The Forestdale Manufacturing company of Forestdale, R. I., will light their mills in the future by 300 incandescent lights —Sawyer-Mann system. A forty-five horse power Westinghouse engine will furnish the power to furnish the dynamo.

——E. W. Tisdall, Philadelphia agent for the Brush Electric Co. has just concluded a contract with the Pennsylvania R. R. Company for a 500 incandescent electric light plant to be installed in their shops at Camden, N. J.

—— The Menominee Electric Light Co., of Menominee, Mich., have recently purchased through Alexander Kempt, the Chicago agent of the Brush Electric Company, an incandescent electric light dynamo with a full complement of lamps. This company is now burning in the neighborhood of 180 Brush arc lamps with a large number of Brush incandescent lamps.

The Work of the Telephonists.

The Papers Read and the Accompanying Discussion.

Underground Work in New York and Brooklyn Discussed.

Minneapolis, Minn., Selected as the Next Meeting Place.

The Tenth Convention of The National Telephone Exchange Association ended its labors at 2:30 P. M., Thursday of last week, at the Hotel Brunswick, New York.

The first paper read Thursday was by Mr. C. E. McCluer, of the Southern Bell Telephone Company, and was on "Dynamo Current Interferences with Telephone Circuits." It will appear in a later issue.

Mr. T. D. Lockwood followed with his paper as follows:

"On the Electrical Relations of Telephone and Electric Light and Power Circuits and Railways."

This paper deals altogether with the disturbing effects of electric light and power currents upon telephone lines, and not at all with the dangers of imperfect construction and insulation; nor with the results and prevention of dynamo current crosses, there being sufficient in the latter branches of the subject for a separate and equally voluminous paper.

It will consequently be assumed for the purposes of this paper, that the important precaution of effectively insulating wires conducting heavy currents is observed, and that "undertakers' wire" is, as it ought to be, a thing of the past.

The telephone exchange business was commercially organized and established in the first months of 1878.

Electric lighting as a commercial industry had its beginnings in 1878 and 1879, but did not at first take root with the same degree of rapidity which characterized the exploitation of the telephone, and not until some years thereafter did it achieve popularity.

Consequently the telephone systems obtained considerable start, and were firmly established in nearly every city and town in the country before the organization of any electric lighting systems. It was not at the outset generally known that the telephone circuits would be annoyed by the presence and proximity of parallel electric light wires; and telephone companies were thus at first most liberal in permitting the erection near their lines, of foreign lines carrying heavy and widely fluctuating currents.

Yet a little thought and consideration would have laid bare this danger. We knew that the telephone current was itself of the most shadowy and almost intangible character in point of strength, and that to utilize it, such a supersensitive instrument as we all know the telephone to be, was actually essential; and we knew that *because* the telephone receiver was such a delicate electroscope, and so sensitive to electric motion, we had heretofore been much annoyed by mutual telephone induction, by telegraphic induction; and by miscellaneous induction. So, as I say, if we had carefully considered the matter, we might have foreseen the full extent of the electric light disturbance which is now being maintained.

But we did not foresee, and as a result of our lack of foresight, indiscriminate construction has ensued; and in consequence of improper construction, the business of many telephone companies has at certain points been directly or indirectly injured by the presence and operation of electric light wires, and an appeal to the courts has been rendered necessary.

Until within a comparatively recent period, the disturbance resulting from dynamo current induction was, with an occasional and rare exception, limited to certain evening hours, and to the night, because during such portions only of the day were the lighting circuits in operation. But of late, in many places, the wires used in the night for lighting are also used during the hours of daylight for transmitting power from the dynamo to large numbers of motors, which may be widely distributed; and as this utilization is certain to have in the near future an enormous expansion, we are compelled to face the prospect that even during the hours of business, telephone wires are now liable to severe disturbances. Therefore it seems time to call a halt; we could be patient so long as we were only called upon to suffer from the "pestilence that walketh in the darkness," but when we are also threatened with "the destruction that wasteth at noonday," it behoves us to have something to say about it. Superadded to the above causes, we now find that electric railways are being introduced in rapid succession, and we find to our cost that many of them are much more active than are electric lighting circuits in setting up disturbing currents in telephone lines; the disturbing current from electric railways being frequently sufficiently strong to vitalize the annunciator magnets of a telephone central station, and to actuate the drops.

Now, I have no quarrel with electric light and electric railway companies considered as such. No man rejoices more heartily than I in the triumphs of electricity, and in the tremendous spread of its usefulness; I recognize fully, moreover, that the lighting, power, and transmitting utilizations of this mighty form of energy are fully as useful as is its function of carrying intelligence, and that these utilizations have properly become permanent institutions, and equally with our own public conveniences. Nevertheless we were first in the field, and although we may admire both the energy of the electric lighting current, and the energy of its introducers, we must in our own defence be prepared to take the position that no new-comer has a right to construct his plant in such a way that an established business shall thereby be ruined or impaired; and that if it be absolutely necessary to erect electric light lines in proximity to telephone lines, the construction must be of such a character as not to involve detriment to the pre-existing telephone lines.

Can electric light and power lines be constructed so as to be near telephone lines without interfering with them? Certainly they can.

Consider how the disturbing currents originate. First: Most arc lighting circuits can set up considerable induction on telephone lines.

Second. Alternating currents in main wires, whether used for arc or incandescent lighting, are intensely provocative of induction and noise in telephone circuits, the character of the disturbance being much worse than that which is produced by lighting currents of constant direction, this latter sounding in the telephones like a protracted musical note of great volume. In speaking of the above, it will be understood that the detrimental action upon telephones is the same when the dynamo current is used for motors as it is when used for lighting.

Third. Certain classes of electric railways very seriously interfere with the operation of telephone lines, both in conversation and also by establishing thereon a current which permanently excites the annunciator magnets. The noises which are produced in telephones by dynamo current induction are so well known that it would be waste of time to describe them.

When the troublesome currents are produced by electric light or motor circuits they may usually be attributed to induction, although a certain amount of absolute leakage doubtless also exists. Since, however, both causes produce in telephone circuits a like effect, it will be sufficient to speak of induction only. But if we consider the action of electric railways upon telephone lines, we find that the major part of the disturbance is due to the actual transference of a portion of the electricity which actuates the train motor to the telephone lines, by way of the rails (when these are used as return conductors), the crust of the earth itself, and the telephone line terminal ground wires.

As most of us know, the alternating current has received lately an increasing amount of the patronage of our light-producing friends; and at the present time both constant direction and alternating currents are largely used in electric lighting and power-distribution circuits, the intensity of the disturbance varying with the class of current employed.

The violence of the induction, and therefore of the disturbance, depends upon the proximity and longitudinal distance of parallelism of the disturbing wire, the strength of the inducing current, the frequency or rate of change per time unit of the inducing current, and the extent or range of such change; that which is due to wires carrying alternating currents is, of course, much stronger than even the worst case of direct current induction, for even though the distance of exposure and the strength of the inducing currents be identical, it is self-evident that a current which is completely reversed a great number of times per second must be much more energetic, as a disturber of the peace, than one which is constant in direction and which varies only in strength on one side of the zero line.

These considerations indicate that our methods of prevention or cure should be directed at the stronger disturbing agency, since such a degree of success as we may be able to achieve against that will necessarily be equally effective as regards the weaker.

The proper way to cure or neutralize electric light or power induction *is to prevent it*. It is quite within the bounds of good construction so to relatively arrange lighting and telephone circuits that no disturbance will result; and it is obviously much easier and less costly to construct them properly in the first place, than it is to change them. To secure this most desirable result, viz: the harmonious co-existence of these widely differing classes of electric service, I wish to point out that co-operation between the parties concerned is absolutely essential; together with a clear and full understanding of the conditions involved. Yet in too many instances, though, as I have stated, the telephone wires were already in the occupancy of the field, telephone companies have negligently omitted to watch their own interests with sufficient care, and have without remonstrance permitted electric light companies to erect wires close to their own, and of such a character as to render inductive disturbance a foregone conclusion. Would not a general good understanding between the different electrical interests of any city or town be desirable for the forestalling of such chances of future disagreement? Informal discussion, amicable conference and mutual consideration between the authorities of the several interests would tend to preclude any possible future misunderstanding, and would certainly act to prevent unnecessary antagonism either between any of the several individual interests or with municipal authorities. A good understanding all round, is therefore suggested, as being an admirable forerunner to a system of non-conflicting construction.

Local managers of telephone companies should be instructed to report to headquarters at once, the intended construction of either electric light or railway circuits at any point within their territory, so that proper measures can be concerted and adopted to meet the special conditions of the case.

If the general satisfactory understanding which I have outlined can be reached, it should not, I conceive, be difficult to bring intending electric light and railway officials to see that construction which is innocuous to their neighbors, and which, in virtue of the provisions necessary to secure such innocuousness is thereby safer in all respects, is (all things considered) both cheaper and better than construction which is at any time liable to involve them in trouble, misunderstanding and damages.

The element of distance is of the highest importance. Telephone and electric light wires cannot be too far separated for the efficient working of the former; and the wires last strung should be run, if possible, on the other streets from those in which wires are already in operation. In no case ought the two classes of circuits to be nearer together than the width of an average street. In writing the above, I have not forgotten that it is oftentimes a matter of mutual convenience that reciprocal privileges shall be allowed. This idea is by no means in conflict with the general principle that distance is the most efficient neutralizer.

The good feeling and understanding which I have advocated will be productive of a tendency to keep down unnecessary pole construction, and if either interest have a pole line through a certain territory, and if the other party have but a few wires going in that direction, it is doubtless often the best policy and practice to make the existing pole line available for both. By suitable agreement on this head, both telephone and electric light systems are enabled to use each others poles on occasion, and thus to carry a sporadic line, and accommodate a customer in a district which could not otherwise be reached, at least with due regard to economy. It is, of course, understood that an electric light company thus stringing wires on the poles of a telephone company must properly run its wires so as to produce at most a minimum disturbance; and that a telephone company taking its chance on electric light poles must not expect first-class results, unless it be returned through the region of disturbance. The responsibility in the latter case is on the owner of the telephone wire alone.

If both sides of the street be fully occupied, and it should be really necessary to carry a main route of wires of both systems on the same side of any street, no other street being available (a state of affairs which ought not often to exist), it would, I should say, be better for them to be upon a single line of large poles than for each company to provide its own poles, and thus to incur the enmity of abutters, property holders, municipal authorities, and iconoclasts generally, for a uniform style of construction can then be adopted, and as the telephone current is the weaker, the telephone poles should carry both sets of wires, and the construction should be supervised by its officials. This procedure is, however, only admissible if no other route can be found for the wires of that concern arriving last on the ground; and I repeat that, wherever circumstances will permit, the width of an ordinary street, at least, should intervene between the wires of the two systems.

Electric light and power circuits ought always to be metallic; and, in fact, every self-respecting electric light circuit *is* metallic; this however being altogether without regard to its relations with contiguous circuits of other classes.

But a lighting or power circuit which is contiguous to telephone circuits must not only respect itself, but must respect the telephone circuits also, and hence must not only be a metallic circuit, but must have its two wires parallel, and as close together as possible, so as to be practically equidistant from the telephone wires; this, in order that the inductive effect exercised by the outgoing and incoming wires may be equal and opposite.

Where the distance of the width of the street is observed the parallel return wire frequently provides all the necessary neutralization, and prevents disturbances, for the neutralization is necessarily more perfectly effected, as the distance of the two wires of the electric light circuit from the telephone wires is increased; because the distance of the two wires of the lighting circuit from one another is a much less factor in a greater distance, such as the width of a street, and and the two wires therefore operate much less independently than is the case when each wire is almost as near to a group of telephone wires as it is to its own mate. It is however often also found, (and especially when the two sets of wires are on different horizontal plans of the same poles) that even though the two wires of the lighting circuit be substantially equidistant from the telephone wires, perfect neutrality and noiselessness is not secured; and the degree of remaining disturbance is greater or less according to the distance between the wires of the two systems, and the distance that the said two sets run in parallel contiguity. This remaining disturbance manifests itself because the electric light circuit is not balanced If, for example, one of the two sides of a lighting circuit be made to serve one or more latertal loops, while the other runs straight; or if one be connected with a greater number of lamps than than the other, there is no balance; the electrical centre of the main line does not coinside with the mechanical centre, and one of the two wires exereises a much greater inductive influence than the other; the result being—*noise*. By arranging the electric light circuit so that each side shall have an equal number of loops of like length, and an equal number of lamps or motors, and then by transposing or crossing the two wires of the lighting circuit about every fourth or fifth pole, the disturbance may be totally suppressed.

Such care in construction will most naturally be objected to by electric light and similar companies, on the plea of expense, especially by such as have already constructed their lines in a style regardless of the rights of others; yet only by an insistance upon such conditions when the two systems of lines are in close proximity, can the business of telephone companies be protected.

It may also be objected that since the parallel return-wire cross connected at intervals with the outgoing wire, is a remedy for inductive disturbances, it is one which should be applied by the telepone companies, and to the telephone circuits, as being the complaining party. But as to this, in addition to the already stated fact, that in nearly every case where the pernicious effects of induction are experienced, the telephone company was already in business, and its wires in place; and that the disturbance originated with the advent of the electric light wires; and that common justice requires that the aggressor should apply the remedy, it may with reason be rejoined that the number of the electric light wires is much less than that of the disturbed telephone wires, and therefore the remedy may be applied to the former with much greater case, and at much less expense.

We have considered the preventive or remedial measures which are applicable to this evil; and it seems clear that the right time for suggesting the propriety of observing these conditions of neutral construction is before the work has been done; and it is probable that the owners of disturbing wires will be much more willing to heed them, in originally arranging their wires, than where subsequent alteration is required; especially as in original construction, the plans suggested would not necessitate the numerous joints inseparable from later transpositions.

In any case, whether such remonstrance or suggestions as may be offered tending to harmless construction, be properly received and acted upon or not, it is our duty to offer them, and so to place ourselves in the right, and in the unmistakable position of having at least done our part in objecting to *improper*, and in stating our convictions of what constitutes *proper* construction.

I have already attended to electric railways, and to the fact that the weight of the evidence in regard to disturbances developed by them upon telephone lines tends to show that these are due not to induction, but to actual condition of electricity from the railway conductors to the telephone lines.

There are several classes of electric railway.

1. Those which utilize the rails for both outgoing and return conductors.

2. Those which employ a single overhead conductor, using the rails as a ground terminal or return.

3. Those in which the two main conductors are both in a conduit, to which access is had through a slit, in the same way as a mechanical cable road is operated, trailing brushes or springs being led through the slit.

4. Railways which carry their own elec

trical energy in the form of secondary battery cells.

5. Railways which employ two overhead conductors; one as the outgoing, and the other as the incoming line.

Of these plans, the first and second are very detrimental to the satisfactory operation of telephone lines; the fourth is perfectly harmless in all respects, and the third and fifth usually are also, and may be readily so made when they are not; all that is necessary to that end is to exercise such care in construction as to ensure that the main conductors are properly insulated, and in the case of the fifth plan, that the main conductors are also prevented from coming into contact with overhanging branches of trees.

A great number of electric railways are built upon the second plan, and where they are run near telephone wires invariably exert a pernicious influence thereon, which is largely due to the imperfect return or earth terminals furnished by the rails; a portion of the current running from them through the earth to the telephone circuits by way of the sub-station ground wires, this occasioning interference with conversation, and affecting call signal apparatus, and often damaging property.

This class of construction is manifestly improper, both on the score of interference with the telephone wires, and as being dangerous; and is of the cheap and reckless order.

When the remedies for its evils are so simple and consist merely in adding a second overhead conductor, and in looking well after insulation, it would seem that they should be promptly and universally applied by reason of the greater security they afford even though those owning railways may have no just regard for the rights of others.

Telephone companies should therefore exert themselves and their influence in favor of the double overhead wire and other safe forms of railway; the former being in fact safer in other respects and more economical in operation than railways which in any way utilize the rails as conductors.

Where other systems are already in use, and should it be found impossible or impracticable to persuade the railway company to provide a return wire, and where the telephone service is consequently impaired, the only absolute remedy is that of providing the telephone circuits which are affected, with a parallel return wire.

The disturbances may however be greatly softened down or subdued by carrying the ground end of the subscriber's wire from his office or house to some point at a considerable distance at one side or the other of the railway, and by there terminating it, instead of at the sub-station itself. Considerable success has also been attained in practice in the amelioration of this trouble, by connecting the leading out wires of a number of neighboring disturbed telephone lines with a large common return wire grounded at or near the central station, instead of grounding each in the ordinary way.

If the leak is so great as to affect the annunciators, it is sometime requisite that the common return wire instead of being grounded, shall be connected with the several central office terminals of its group of lines, exactly in the same way that its outer end is united to the outer ends of the individual lines; that is, of course, when these are at rest. By adopting this plan the earth connection is, when the lines are not in operation, completely cut off. If the disturbance does not affect the talking, ground connections can be provided for use during talking. If it does, then the return must be retained during talking also.

Though this paper is already long, there are still one or two points on which I could touch. In one of the children's hymns composed by the late lamented Dr. Watts, occurs these lines:

> "One sickly sheep infects the flock,
> And poisons all the rest."

And upon the principle thus enunciated, it not infrequently happens that though but few telephone wires, or even but a single wire be exposed to disturbance originating in and by the causes recited, the trouble is propagated to others by induction by reason of the close massing of large numbers of wires at, or in the vicinity of, central stations.

Consequently, one wire adversely affected by electric light, or railway disturbance, may influence deleteriously many others.

The lessons we have to learn from this, are that if we have *one* wire so offected, we ought in some way to promptly attack the evil in that one wire, remedying the trouble while it is small and controllable, and that it is essentially our duty to remove dead or unused wires at once, unless there is good reason to anticipate an early resumption of use; and even then they should be disconnected from the two terminal stations; and when I say disconnected I don't mean simply short-circuited, or cut out, but absolutely detached; dead wires being one of the most prolific and active agencies of disturbance and danger. True, it costs something to take down wires, and it may be troublesome to put them up again when required, but it is the only safe proceeding, and in such matters the anchor ought to be thrown to windward every time. It is better to spend a few cents in defence, than it is to spend possibly millions on account of the misdoings of a dead wire, in tribute.

Finally, if the number of disturbed wires be smaller than that of those causing the disturbance, or if it be necessary to run a telephone wire through a region of disturbance, the simplest, easiest and most economical way, is not to monkey with the buzz-saw, but at once to make the telephone circuit metallic, at least through the region of disturbance, which operation should, moreover, invariably be performed in cases where less drastic measures fail.

Mr. Lockwood: Now one word as to Mr. McCleur's device. It is, true, as I said before, that the evil he has had to encounter is actual leakage from the rails and that it has manifested itself both by affecting the coil apparatus and by affecting the conversation, and there was no reason even before he tried his device to doubt that it would do its work. I do not know whether it has totally eliminated the noise, but if it softened it down fifty per cent., as he says, if it has made it bearable so that people can talk, a great deal has been done. There have been since the beginning of the telephone business, I think, some six hundred patents issued for different forms of telephone, and I think, perhaps from three to four thousand patents for telephone appliances, out of which perhaps two hundred have directly or indirectly referred to systems or arrangements, or pieces of apparatus for reducing, eliminating or neutralizing inductions. A great many are not worth the paper they are written on. But this device of a return circuit I think, probably, was first indicated by the old way in which those of us who were telegraph men used to run what we called combination locals. We used to have a number or combination of local battery cells, one for each sounder, and we would bring them all back over a common wire. A little later when the telephone business began, quite a number of people, myself among others, patented a system in which a common return wire was provided, or a group of circuits. That was in 1880. In the application for a patent that I put in, we had a narrow escape from an interference with some of Mr. Scribner's application for patents which afterwards went into force throughout Indiana, Ohio and Illinois as the Wiley-Scribner Telephone Exchange system. I know Mr. Durant remembered it because he has been in interference with him. Since then the very idea of using a common return as an induction neutralized has been patented by a man named Bentley, and within the last six months the American Bell Telephone Company bought that patent with a lot of others, and the American Bell Telephone Company buys patents so that its licensees can use them. I have not made these observations with the idea of belittleing Mr. McCluer's invention, because there is not the slightest doubt that he invented it independently and and for his own work; but simply to say that none of the rest of you, if you wish to use it, need hesitate for fear trenching on his prerogatives, because it is open to every one of you who are licensees of the Bell Telephone Company,

Mr. Durant: I would say that we have for three years used that device and have it in use now. I think it is applied on twenty-four wires. It came into use from the interference of the Heisler incandescent system, which uses an alternating current. I was surprised to hear Mr. McCluer say it was novel.

Mr. Bailey: I would say in relation to the troubles from electric railways that our experience coincide in almost every particular with that of Mr. McCluer, and further, that in so far as the gentlemen who are at the head of these railways can do, they are willing, we have found, to do what they can when they are told how to do it. The trouble principally has been that enterprises of this kind are organized, and foisted upon a lot of gentlemen who heretofore have not been in the business. The lines are constructed usually by construction companies that are sent out generally from New York city. Those gentlemen, as I said before, who own and put their money into these companies, know nothing about the requirements of their own business, but they take everything in good faith. It is the interest of the construction company to get through with the work, and get the money and get out of town as soon as possible.

The only course of safety for the telephone companies is eternal vigilance, during the process of construction, in raising objection to anything that they may find deleterious to their service. Now, the only railways with which I am familiar are those having a single overhead conductor with a rail return, and with them it is necessary to preserve a uniform elevation above the center of the roadway. In doing that it is almost impossible for them to construct the lines in such a manner as not to interfere with the telephone circuits. Their ordinary height, I believe, is regulated at sixteen feet above the center of the roadway, and it is necessary to put up poles on each side of the street about twenty feet in height, and in practice they put them up a good deal higher in order to carry the suspension wires high enough. In the operation of the railway these trolleys running along on their conductor wire have the effect of breaking their insulation, and in the course of a little time, no matter how well they may have attempted to insulate their wires, the insulation becomes very defective, and the current leaks from the suspension wires and guy wires and everything of that kind.

Therefore, a line of poles set on each side of the street and charged in the manner in which they are, are very dangerous in regard to any other telephone wires or any other wires of the kind coming into contact with them. Of course, that is only a matter of mechanical construction. I should think they might be insulated so as to prevent absolute crosses. We note the same result of leakage from the earth to our telephone wires as we have from the grounds of an electric light circuit. You take an ordinary electric light circuit with one ground and you find no difficulty, no damage; bnt the minute they get two they get trouble. We have frequently found trouble from electric light circuits which, when traced, were located in electric lights being in contact with gas fixtures so badly as to throw currents into our exchanges that would throw down one hundred or two hundred drops at a flash. We complained of one the street railways in Scranton, and at last threatened to take legal proceedings to obtain relief, and sent up to New York for some experts. Among the rest was Mr. Prescott, a very prominent electrician here, who came to Scranton and examined the system, and said it was a matter of induction entirely, and it was folly to suppose that an electric current would leak from the earth to any other conductor.

After it once got to the earth it was dissipated. Of course the opinions of those gentlemen are worth considering. At the same time, the trouble continues. They went to work and improved their insulation, and have removed the trouble from a good many of our lines. In some lines they are affected still so badly as to hold the annunciators to the coils, and, of course, the talking service on them is very poor. We adopted that same system, which Mr. McCluer speaks of, on some of our lines with absolute release—that general return wire. It was not original with me; I got it from Mr. Denver, of Boston, and we found it did give us absolute relief. We have not adopted it generally; but in using that method I cannot see any objection to using a return ground and having it connected with the general ground of the exchange. But if that general ground if led off to some other point not returned parallel with the wires that are served, I do not think you get very much relief. We tried that in Scranton. We got a little relief, but very little. It is very certain that a current from those electric railways will set up currents not only in parallel telephone lines, but in lines that reach the line of their railway by a different route altogether.

The President: Does the chair understand you to say that it is not material whether the ground wire returns to the central office or whether you run it off in another direction?

Mr. Bailey: It is very necessary; but I say some lines are affected by the railway, which lines take a different route to reach the railway.

Mr. Gifford: You do not believe it absolutely necessary that they should run the general current parallel with the telephone lines?

Mr. Bailey: I think the general current should return on the same line of poles as the lines that are served, and as near the centre of the line as possible of those lines that are served. I think you get better results than you would if you hung it below or above.

Mr. Gifford: You said that this return of ground wires, to obtain the best results, should be parallel with the lines of overhead wire and then be connected with the central office ground wire.

Mr. Bailey: We connect it to the central office ground.

Mr. Gifford: We have twenty different routes in different portions of the city. Is it practicable to connect all those returns coming from different portions?

Mr. Bailey: So long as you do not overload your ground wire above its capacity. You can start out as Mr. McCluer says, with a heavy wire, and as you have less wires to serve, use a lighter wire.

Mr. Durant: I think you misunderstood Mr. McCluer as to the location of the ground. He said it was immaterial whether it was in the central office or at some point remote from the center of this disturbance.

Mr. Bailey: I think it is immaterial; although the general ground should return on the same route with the wires that are served on that ground, and as nearly equi-distant as you can place it from the wires that are served. There is another point I want to call your attention to—that matter of danger of dead wires in relation to lighting trouble. We have had a little of it out in our country. Of course we have a system that covers a good deal of country, and is made up largely of country lines, and in the changes in telephone business dead wires occur with us as they do with everyone else, and dead wires are sometimes a good deal more costly than living ones. It reminds me of the case of the old man who was a gatekeeper for one of the railroads in our town. His business among other things was to keep intoxicated persons and persons of improper character from getting on the trains. One night a lumberman, very much intoxicated came to the depot and the old man put him out. The lumberman was smart; he went down the track and climbed over the fence. But the old man was watching for him, and he shoved him out of the gate, and as he did he said: "Go out; living you are not worth a cent, but dead you are worth $5,000." That is the figure in Pennsylvania which a dead man is worth.

Mr. I. H. Farnham: I would like to say just a word or two on the paper of Mr. McCluer. He suggested a plan, or, at least, he suggested a fact that might exist, which I thought might be misunderstood, and might be misleading. He said in a large place where there were several electric light wires running that one might offset—in a certain sense—the induction from another wire, and so the difficulty need not be as serious as it would be where there was only one circuit. I have found in several cases, in looking up these same troubles, that the electric light people have taken that ground, and have said that their system was all right, because notwithstanding the fact that each circuit was a belt circuit, yet the several belt circuits were on the same pole with what they call the positive pole of the machine, and that consequently the interference of one line would be neutralized by the interference of an entirely seperate circuit. Of course we will find, if we try it, that this is altogether false, because we cannot have two machines running at precisely the same speed and the changes of current coming together at precisely the same moment of time, and while there may be, in listening at a telephone, a moment when the noise is less, the next moment it will be very severe. One of the noisiest exchanges that we have is where the circuits run in belts on the same poles, and yet there is no balance whatever. I speak of that because unless we understand it thoroughly and are ready to answer the electric light peoples' question in that matter we may get ourselves into trouble. The only way to remedy that is to take two of those circuits and make a metallic circuit; if there happen to be four or six circuits, taking the same general route, of course; that can be arranged so that there will be a metallic circuit of each individual circuit on the same poles without materially increasing the obstruction.

In speaking of the electric railways, nothing was said, I think, in the paper or in the remarks, about the feed wire. Sprague's system uses a feed wire. I do not know about the Richmond system, but I do know one system in New England where this feed wire is also a bare wire. It certainly is bad enough to use a bare trolley wire with a grounded circuit, but where the excuse is for using a bare wire in places where our wires are liable to touch them at any time I cannot conceive.

Prof. Van der Weyde: I am in a position to mention certain results in regard to that general return wire, which I obtained in a series of experiments that I made some years ago with the purpose of economizing the wires with a double metallic circuit and having one general return wire. I found that if a general return wire, substituted for a ground wire, is not close to the direct wire it is of no use. I found that it is only reliable when the wires are all connected together as much as possible in a cable. If they are some distance one from the other when one direct wire is nearer to an electric light wire, or the return wire is nearer to an electric light wire than the other, we will have inductive influences. Therefore, I adopted the system of making as much as possible a return wire—a well-insulated return wire of low resistance in the center. I found that to be a very reliable method of obliterating the disturbing effects not only of direct electric light currents, but also alternating currents; but it cannot be insisted upon too much that the return wire and the direct wire should be as close as possible together. I was at that time very much pleased with the result, and was advised to take a patent for it. While it is easy enough to get a patent, I found after I had it that it was common property, that a great many had the same idea, and that patents had been given right and left for similar ideas—that metallic return wire. But I cannot highly enough recommend it. It will surely give satisfaction whan well applied—not at a distance, not at the other side of the street, only when closely connected, and if possible in a cable.

Mr. Seeley: I would like to state our experience with a common return wire for subscribers. In New York City in 1885, we put up a Paterson cable. In those days they made a cable with a large center core; I think it was a No. 6 wire. We connected

to that cable some 500 subscribers. We grounded that central core in the central office. While that cable worked fairly well and cut down the induction and cross-talk and leakage, we discovered by ringing up a subscriber on a long wire, that we would also ring up a subscriber on a short wire, and that with two wires of the same comparative resistance, if two subscribers would attempt to talk at the same time, the cross-talk between those two relative wires would be very severe. We immediately abandoned the scheme, and considered it useless. I would also like to state while I am here before the convention, that I presume in New York city we have a larger number of electric light wires in the air than are in any other city in the world. All systems are represented here. It is the policy of the Metropolitan Company to grant pole privileges to those companies. We have a blank form on which they make application to the company, and by so granting them permission to erect their wires on the property of the Metropolitan Company, we are in a position to dictate to them; we tell them exactly how we desire their wires to be constructed; how many lamps on each circuit; whether we should divide the lamps in positive and negative sets. The East River Electric Light Company have about 2,200 or 2,500 attachments on our poles, and their wires are built in the most excellent manner. We are suffering very little from the leakage from their currents. They use the Thomson-Houston system, and are giving us no trouble whatever.

Mr. Thornberry: It seems to me that providing this return wire is providing a method almost as expensive as it would be to the electric light company if they returned their wire, which in equity and justice they should do. It does not seem to me that the telephone companies should establish a precedent which the electric light companies may force them to follow afterwards. It is not anything but right that they should put their systems in such a condition as not to interfere with your service. If you are on the ground first you have vested rights. If you go into a district where they have built before you, they have vested rights, and you should then provide means to equalize the induction on your wires or substitute some method on theirs, that is, give them wire to lengthen out their circuit and return them in the proper manner. The return wire method, as Mr. Seeley has pointed out, has its defects, and the greatest defect it has is that the current on one circuit will divide itself and go back on the other if the return wire is not of infinite resistance. Mr. Seeley tells me has used a return wire also; but No. 4 copper and No. 6 copper is the wire ordinarily used for electric lighting, and for that length of line, if the electric light company run on one street and return by another, Mr. Farnham had better have given the electric light company the necessary wire to return their circuit on the same street, it seems to me. I think the Convention ought to take some action in convention with the National Electric Light Association. I was almost ready to make a proposal that this Association appoint a committee who might meet a committee from the National Electric Light Association to discuss the matter of providing methods and means whereby we might harmonize the interests of the two companies.

Mr. McCluer: I have repeatedly gone to my office at night, taken this plug out of the switch and disconnected the systems from the ground entirely, got two, three, four and six people to talk at the same time on different wires on that circuit, and not one could hear a word that the other said—not as much cross talk on that as on wires I have running down Carey street on the same pole. Now, that is a fact. Of course I made inquiries from some of my electrical friends that I thought might possibly have heard of the adoption of this principle before I did, but it was new to them, as it was to me, and I never had seen any intimation of anything of the kind being done in any of the public prints, although I am the subscriber to two or three technical journals. I then disclosed the plan to our executive officers, and had a good deal of correspondence with them with reference to the matter before any decision was arrived at. During the progress of our correspondence I heard that Mr. Durant, of St. Louis, had tried the return ground system, and as it was told me, without any result. I was also told that an English electrician, a telephone man, had reported that in England they had tried the same thing and had found they obtained a better result by connecting the two ends of this common return wire to the ground also, using the earth and the wire together. Well, that was a revelation to me. I thought possibly there might be something in it. I had not thought of trying it before, but I did try it, and just the very moment that the earth was connected on the wire again, the same interference that we had before showed itself, but the very moment the earth was disconnected from the common return wire all this interference disappeared.

Mr. Lockwood says he did not understand me to say that it was my intention or expectation to connect any considerable number of wires to the same line. I do propose to do that. I propose to have only one wire of large conductivity on every line of poles. It does not matter whether the pole carries twenty-five wires or two hundred and fifty wires. In telephone practice we use a single wire and very often a No. 8 or No. 9 iron wire for a ground wire, for half a dozen or a dozen different circuits for carrying currents of greater electro-motive force, of course, than we put on our telephone wires.

Here is a letter that I wrote to our general superintendent with reference to this scheme, in which I was combating the idea of using a wire of low conductivity and giving my reasons why it would be advisable to use a wire of large conductivity so as to provide for any possible leakage, because, as you understand, that if the resistance of this common wire, which I call the artificial ground wire, is not low enough, there is going to be a leakage to the other currents.

The following table will show the resistance for half a mile, one mile and two mile lines as I think they should be arranged:

½ mile No. 14 iron wire	23.92	ohms.
½ mile No. 4 copper wire.....	.65	"
Proportion 36.80.		
1 mile No. 14 iron wire.....	47.82	ohms.
½ mile No. 4 copper wire..	.65	"
½ mile No. 6 copper wire. .1.04	1.69	"
Proportion 28.29.		
2 miles No. 14 iron wire.....	95.64	"
½ mile No. 4 copper wire.....	.65	"
½ mile No. 6 copper wire.....	1.04	"
1 mile No. 10 copper wire.. 3.04	4.73	"
Proportion 20.21.		

Or, if we use one mile of No. 14 instead of No. 10 we should have:

½ mile No. 4 copper wire.....	.65	ohms.
½ mile No. 6 copper wire.....	1.04	"
1 mile No. 14 copper wire.....	4.91	"
Total.....	9.60	"

giving 9.96 as the proper, or a small fraction less than one-tenth of the resistance of the line wire.

Now, as I say I am using this one single wire composed of this compound conductor, half mile No. 4, half mile No. 6 of the remaining distance, in some cases, a mile and mile and a quarter of 14 wire with 87 stations connected on to that, and only taking earth at the central office, and I am working them to day without any interference and with a decided improvemsnt in the character of the service. When I disconnect that wire from the ground at the central office, there is not a particle of leaking from the voice or battery, except that on some of the longer lines where we have got a mile or a mile and a quarter of No. 14 copper wire there is a leakage from the battery current. I believe candidly that the substitution of a No. 3 copper wire in place of that No. 14 will remedy that ill.

Professor Van der Weyde: I wish only to state that, according to my experiments, it is possible for 20 or 30 operators on a telephone line to communicate with one single return wire. My experiments were made five years ago in anticipation of the necessity of putting the wires underground. I found that with one return wire I had as many as 20 or 30 different wires between which communication could be had, and that the call could be rung without mutual interference. Then I got, by the kindness of the telephone company, the use of a number of cables containing some hundred wires and a central wire. They call it the Patterson wire. But the results were unfavorable, for the reason that the cable was connected at both ends with the ground.

Mr. Reilly: I would like to say that something over three years ago we had occasion to run a common return ground, such as Mr. McCluer described, to overcome the induction from the Delaney synchronous telegraph on a line parallel with ours, for about five miles. We ran a number 12 copper wire for about four miles and connected to it six stations and almost entirely overcome the noises from the telegraph wire and suffered no interference whatever from ringing from one station to another, and had no interference from cross talk. That line is still in use and giving satisfaction.

Mr. Seeley: I beg to ask the indulgence of the chair while I make a few remarks on the subject of dead wires. Mr. Lockwood referred in his paper to the great disadvantage and the great amount of trouble caused by dead wires hanging in the way. I would like to say that I think every city should have a subway commission. Of course we have one, though it is very much abused; but they are removing the dead wires fast in New York city. They take down the poles and wires, and the companies have no trouble whatever in removing the dead wire. They do it for them.

The President: If there is no further discussion on this subject we will hear the paper by Mr. Sargent on the subject of Underground Wires in Brooklyn.

The secretary read this paper as follows:

"UNDERGROUND WORK IN BROOKLYN," BY W. D. SARGENT.

The extension of underground conduits in Brooklyn has been restricted since my last observations on the subject to short sections for the purpose of connecting our new buildings in the Brooklyn and Williamsburgh districts with the underground system. All of the new conduits have been made of the creosoted wood, the ducts three inches square, inside measure, with the exception of one short section of Macdonald creosoted wood, with round holes 2½ inches in diameter. It is fully decided, however, that hereafter no ducts will be laid with an opening of less than three inches in the clear.

In order to make ample room for the conduits reaching to our principal office, 16 Smith street, we have built a tunnel the whole width of the street, high enough and wide enough to walk through, and it now carries 108 ducts, with room perhaps for 60 or 100 more. There are special features in this tunnel and method of bringing the terminals of the cables into the building which it is difficult to describe or to reproduce in a drawing. The ELECTRICAL REVIEW of August 4th, 1888, gives illustrations which will convey some idea of the character of the work, and the members of the association are cordially invited to visit the office and inspect the arrangements for themselves.

The first sections of our creosoted wooden conduits have now been in service four years. There is no evidence of decay and the ducts remain clean and dry, enabling us to draw in and withdraw the cables without any difficulty.

So far as conduits are concerned, we think experience has fully sustained our judgment in favor of creosoted wood.

One of the most important things, after the conduits, in the underground work, is the manholes, which should be as large and commodious as possible. Within reasonable limits it is almost impossible to get these manholes or working chambers too large. While we from the start realized the importance of this part of the work, we have in quite a number of instances been compelled to rebuild and enlarge the manholes as first designed. Given a conduit of durable material, connecting with commodious manholes, this part of the underground problem, so far, presents no serious difficulty.

The character of the cables to be drawn into the ducts and the method of distributing wires from them, are questions that demand our most earnest attention.

Experience has taught us that larger conductors and thicker insulation, together with twisted metallic circuits, are an essential part of perfect service. Conductors of .035 to .040 of an inch in diameter, insulated to .125 of an inch in diameter and twisted in pairs, with 100 to 104 wires, or 51 or 52 metallic circuits, make up a cable of from 2 to 2¼ inches in diameter. Such a cable will weigh between 4 and 4½ pounds per foot, according to the amount of lead, and on account of the tendency of the lead pipe to buckle in bending, we do not believe that it is practicable to handle cables of larger diameter and weight. The consideration of these facts led us to decide that our ducts should hereafter be three inches.

We are using nothing but the lead covered types of cables, some of which has been in service underground for four years, and is still in good condition. Of the cables which were laid four years ago, those covered with pure lead appear to be more than half eaten through One that has been drawn out during the writing of this article has been underground for two years and is badly corroded, there being holes eaten in it in many places nearly one-sixteenth of an inch in depth. Of the cables furnished by the Western Electric Company at the same time, in which there is a small percentage of tin mixed with the lead, the corrosion is very slight, and we are led to believe that cables covered with this alloy will last from three to four times as long as those covered with pure lead. We believe that if in addition to the tin the cables were drawn through a bath of gas tar or asphaltum, then covered with a good stout braid and run through the gas tar or asphaltum again, the cables would be practically imperishable, so far as the outside covering is concerned, and it is a question whether this additional expense would not be justified by their increased length of life. It is certainly worth the trial.

The air tight terminals, which were put on all our lead cables more than a year ago, appear to have removed all the difficulties which we formerly had at that point, and the tests of our cables, making due allowance for temperature, etc., show that there is no deterioration during the past year.

Of the cables mentioned by me last year, one of 7,180 ft., containing 100 wires, twisted indiscriminately, manufactured by the Western Electric Company, has been reduced by the change to the new central office to 6,344. Tests made August 16th, 1888, give the insulation, 300 megohms; capacity, .22 microfarads; resistance of the conductors, 43½ ohms per mile. The conductors are .038 of an inch in diameter, insulated to .088 of an inch. For a time during the past year all the conductors were in service, but recently the trunk lines to Bedford office have been taken out, and there are now 80 wires working through it. The condition of this cable in regard to cross-talk is the same as last year. That is, it is not bad enough to prevent its use.

The cable manufactured by the New York & New Jersey Telephone Company, with 100 wires, twisted in pairs, has been reduced to 6,117 ft. Tests August 19th, 1888, give the insulation 39 megohms per mile; capacity, .275 microfarads and resistance of the conductors, 48 ohms per mile; temperature in both these cases being, in the air, 80 degrees, and of the water from the hydrants, 73 degrees. We assume that the temperature of the water from the hydrants is the temperature of the air in the conduits. Seventy-four wires are working through this cable, and the cross-talk is no worse than last year and is not so bad as to prevent its constant use. In both cases all the dead wires are kept grounded at the cable terminals.

The greatest length of cable we have now underground is 11,800 ft. between our Bedford and Williamsburgh offices, consisting of 100 wires, twisted in pairs, the pairs broken up at all the splices, conductors .035, insulated to .075. The insulation of this cable is 99 megohms per mile; capacity, .26 microfarads; resistance of the conductors, 47 ohms per mile. Seventeen conductors in this cable are in use for trunk service between the two offices, the rest of the wires being grounded close to the terminals at both ends. The cross-talk in this cable is very slight and is indeed less than in the Western Electric Cable of 7,000 ft.

We received complaints from both these offices that the talking by subscribers through this cable was difficult and unsatisfactory. A special investigation of these complaints at the points they originated demonstrates that the difficulties complained of are not in the cable, but rather in the condition of the transmitters and instruments in the various offices, and carelessness of the subscriber. Considering this cable as a whole, two miles in length, its electrical qualities are, insulation, 50 megohms, capacity, .52 microfarads, resistance of conductors, 94 ohms. We are inclined to think this is about the limit of good working in that type of cable and that the complaints we are getting about the service over it are due to the fact that it loads up the circuit so that there is no margin for any deficiency in the subscribers' circuits connected to it; whereas, if its efficiency was higher there would be a margin to cover such defects, and complaints would be prevented. There is no doubt that the reduction of the cross-talk and the increase in the capacity is due to the fact that 83 of the 100 wires are grounded at the terminals, and that when the whole cable is put into service this condition of affairs will be changed more or less; that is, the capacity will diminish and the cross-talk will increase.

It was a consideration of the difficulties to be encountered in the use of greater lengths of this type of cable, which the above experience emphasizes, that decided us during the past year to make a special cable for our trunk lines, doubling the weight of copper and thickness of insulation. This resulted in our ordering three miles of cable conductors, .052 of an inch in diameter, insulated to .125 of an inch, 60 wires laid up indiscriminately, and during the past two months two miles of this cable, or 10,500 feet, have been put up on the elevated railroad structure, connecting the Brooklyn central office with the Bedford central office. The insulation is between 1,200 and 1,500 megohms per mile, capacity, .27 microfarads, resistance of conductors, between 21 and 22 ohms per mile, at a temperature of 74 degrees. This cable, though of the same length as the one between the Bedford and Williamsburgh offices just mentioned, gives surprisingly better results, the cross-talk being very slight and the volume of sound full and strong. Forty of these wires are grounded at the cable terminals and 20 are in active service.

There does not seem to be anything in the electrical measurements to indicate what causes the difference in the practical working of the two cables, but the results are gratifying and seem to plainly indicate that increasing the weight of the copper and thickness of the insulation is a step in the right direction, and I am inclined to think that grounded trunk wires of this last type may work successfully between our various Brooklyn offices, the distances between which do not exceed two and a half miles.

All the new cables we have used this year have been of 102 wires, or 51 pairs, twisted, laid up in regular cable form, in alternate reverse directions, conductors .035 of an inch in diameter and insulated to .125 of an inch. The insulation of these cables, when placed in position underground, ranges from 1,500 to 2,000 megohms, capacity from .17 to .18 microfarads, and the resistance, 52 ohms per mile. We believe that this type of cable will fulfill all the conditions required in our underground work, but at the present time we have no length sufficient to give actual working results.

The transition period between grounded and metallic circuit systems will be very troublesome and annoying and may last several years. It is our intention in ordering the type of cable just described to make provision in the manholes for joining the sections together by devices which will enable the joints to be opened readily without

cutting the cable, and the pairs broken up in order to prevent cross-talk on grounded circuits; and, at the same time, allow of access to them for straightening them through when twisted metallic circuits are required. The necessity for getting at the joints in this way from time to time and the space required to accommodate connecting boxes is another argument in favor of large and commodious manholes.

The durability of lead pipe, with a slight mixture of tin, the maintenance of a uniform and high insulation, together with uniform resistance of conductors, after four years of service, are indications of length of life that are very encouraging.

Up to the present time we have met with no serious accident in our underground work, either from explosions of gas or the men being overcome with foul air. We believe it quite likely that gas is not as plentiful in the streets of Brooklyn as it is in many other cities, and therefore the accumulation in the ducts and manholes is not so great; but we have bern very careful not to spare any precautions that would insure our safety.

The Dorsett conduit, of which we have five miles, with ducts two inches in diameter, has proved to be very unsatisfactory, and the ducts, on account of inequalities at the joints, will only permit of a cable an inch and a quarter in diameter being drawn in. This reduces the capacity enormously, and is, therefore, a source of inconvenience to us.

It is plainly proved that the use of underground wires reduces the margin of good working very largely, and will, therefore, require that extraordinary care must be taken to bring the service to its highest efficiency at all other points.

The most fruitful source of our trouble is the transmitter and battery, and while there have been very great improvements during the past year or two, there is still room for much more improvement before we reach perfection. The numerous contacts, in the magneto bells and other apparatus, need especial attention and care, and platinum should be used wherever possible.

Another source of trouble is carelessness in running the wire from the insulator outside the building to the instruments in the building. The writer knows of many cases where the subscribers wire is run through the window casing with the ordinary cotton covered wire and but little care taken in the inside of the building to keep it away from possible dampness.

As the mileage of underground wire increases, these and other faults now overlooked will become more and more apparent and the expense of maintenance and inspection will be largely increased. There is only one way to bring back the easy working margin we have enjoyed on pole wires, and that is by the use of metallic circuits, and the sooner we get down to that basis, the better it will be for the service.

The following shows the actual extent of our underground work on Sept. 1, 1888:

Length of Conduit	15.17	miles.
" Duct	105.5	"
" Cable	22.93	"
" Conductor	2055.3	"

1,913 subscribers are working through underground wires using 1,229.9 miles of wire.

The President: I understand from the secretary that Mr. Beckwith has a paper supplemental to this. Is he present and will he present and will he read it.

THE NEW YORK SUBWAYS, BY LEONARD F. BECKWITH.

In the following statement I have recorded a few data relating to the construction of electrical subway in the city of New York, which may be of interest.

The work was commenced in the latter part of 1886, and has been carried on since with but slight interruption each year during the season favorable to out of door operations.

The subways as laid out and built have been authorized and approved from time to time by the Board of Electrical Control, and the Consolidated Telegraph and Electrical Subway Company has been directed by the Board to construct them under its contract with the latter. The execution of the work has been entrusted by the above company to its sub-contractor, the Phœnix Construction Company, which has charge of all subway construction in this city.

The subways have been designed and laid out to meet the main requirements of the chief connecting or trunk lines of the various electrical companies so far as they could be ascertained, and so far as they could be conveniently grouped together. The principle of keeping the high tension electric currents for arc lighting and power in subways on one side of each street, and the low tension electric currents for telephone, telegraph and other purposes in subways on the opposite side of the street, has been laid down and so far adhered to. The question of distribution from the conduits has been wisely left by the Board of Electrical Control to the various electrical companies to express their preference for the method best suited to their special system. This the companies have been repeatedly invited to do, and while some have responded and their methods of distribution having been approved as reasonable and feasible, they have been accommodated as rapidly as possible, other companies have held aloof and refrained from action, apparently wasting precious time and neglecting to occupy and secure their commercial field and districts.

The subways built, except the Edison, are all on the "drawing in" system, which provides a group of tubes or ducts extending from one manhole to another, admitting of the drawing in and out of the electrical cables, and affording convenient access from the street.

Different systems of grouping the ducts in the trench, and different materials have been employed, consideration being held of the importance of the line; the question of cost, the durability, tightness against water and gas, etc. Experience has shown us that a main conduit consisting of separate pipes which can be crowded or curved or kept apart is the best adapted to overcome the numerous obstructions met with underground, and frequently diminishes the trenching necessary. Screw-jointed, asphalted, wrought iron pipe laid preferably in hydraulic cement concrete present the greatest tightness of duct against gas and water, united with the greatest strength. In the case of long telephone lines, the desirability of comparing non-metallic and metallic ducts in respect to their influence on low tension currents has also been kept in view. A continuous line of telegraph and telephone subway is now completed about seven miles long, and the above comparison can be made on five to six miles of this length. The cement pipe and creosoted wood tubes present also features of great merit and adaptability. A special feature of New York subway difficulties is the steam heating underground system, of which the leaks in certain localities greatly interfere with the ducts and cables, precluding the use in such places of materials of construction softening or melting at about 160 to 200 F.

The endeavor has been to provide a subway construction that will be most durable and that will give the best mechanical protection to the cables against injury from settlement of the ground, heat, water, gases, etc. The solution of the electrical question of underground working is one that relates to the manufacture of suitably insulated cables, and belongs properly within the province of the electrical companies. The work accomplished up to September, 1888, is shown in the accompanying tables:

	Feet
Dorsett ducts, coal, tar, concrete	235,837
Zinc tubes laid in hyd. cement concrete	68,883
Creosoted wood tubes	167,175
Cement pipe laid in hyd. cement concrete	216,626
Iron pipe laid in asphaltic concrete	131,284
Iron pipe laid in hyd. cement concrete	1,423,722
Iron distributing pipe	23,301
Edison iron tubes	222,794
Grand total length of single duct	2,489,602

	Miles.
Grand total length of single duct	472
" " " trench	37
Number of manholes	523
Total length teleph. & teleg. ducts	376
" " electric light ducts	96
Length of teleph. & tele. trenches	19½
" " specl. elect. light "	17½

Besides the above, there is still about three-quarters of a million feet of single duct for telephone, telegraph and electric light purposes, authorized by the Board of Electrical Control to be built, that remains to be constructed, besides contemplated lines.

The standard size adoped for telephone ducts is 2½ inches clear inside diameter, corresponding to a capacity of 100 wires or 50 conductors in metallic circuit grouped in a lead-covered cable. The chief portion of electric light ducts other than Edison ducts, are three inches clear inside diameter.

The manholes are all of brick laid in cement mortar, with eight to twelve-inch walls, and concrete bottoms. They vary greatly in form, and are from eight feet by twelve feet to four feet by four feet six inches in size, and from six to twelve feet deep. The street casting used has a double cover; the inner cover and rubber gasget are held down by a wrought iron cross-bar, a bolt, and padlock. The covers are practically tight against water.

The systems of distribution in use are as follows:

For telegraph purposes, an iron pipe from a manhole connects underground with a building or with the foot of a pole.

For telephone purposes the above method is used, and also in connection therewith a pipe running up the face of a building to the roof, where from a fixture the cable is divided for distribution in the block and surrounding blocks. Sometimes the pipe is carried up through an elevator or ventilating shaft. In addition to the above, in the down town district and along Broadway to Union Square, an iron three-inch pipe is laid in the trench above the subway, and provided at intervals of about 50 feet with malleable iron circular distributing or service boxes with screw covers 12 inches in diameter, with side outlets through which a cable can be conducted by a service pipe into the buildings.

For electric light distribution the Edison Company have their special system laid. The "Johnstone" cast iron distributing conduit, with six ducts and flush boxes, has been authorized to be laid in Broadway from 14th street to 35th street, for purposes of electric light distribution, and will provide all the necessary facilities for this district.

Up to August 27, 1888, there were 3,567 miles of wires laid in the subways by the Metropolitan Telephone & Telegraph Company. This company has laid a 100 wire lead-covered "Paterson" cable, from Whitehall street to 58th street, a distance of about six miles; this cable is believed to be the longest of this size in existence underground.

The Western Union Company have about 100 miles of wire underground and the Edison Company about 126 miles. The Brush Electric Illuminating Company are putting an eight conductor "Standard" cable in the Broadway conduit, from 14th to 35th street, a distance of one mile, making eight miles of electric arc light wire.

Other applications for space in the subways, and for the construction of additional electric light lines, are pending.

Mr. Beckwith: I might say, Mr. President, that considering the difficulty of giving any technical details with regard to the work, any gentlemen who is interested in looking up and examining the work, or in seeing the plans or going into a more extended examination of how subways are built in New York, if he would call at 18 Courtlandt street, I should be very happy to give all information I have at hand that lies in my power. (Applause.)

The next paper to be read is entitled "Telephone Exchanges of New York City," by E. S. Sherwood.

Mr. Sherwood then read his paper.

Mr. W. D. Sargent, vice-president, took the chair.

The Chairman: There is another paper to be read by Mr. Plush, of Philadelphia, on the telephone. I think it would be, perhaps, just as well to read these papers and then take up the discussion of them, one after another, for the remaining time that we have before adjournment. If Mr. Plush is here I will ask him to read his paper.

Mr. Durant: While you are waiting for Dr. Plush—I know you are all deeply interested in the Law system—I want to speak of the system we have in use between St. Louis and East St. Louis, which I think is novel. If you are familiar with the Law System, as I presume you are, you know that we use two kinds of call wire, the one metallic and the other an open circuit. East St. Louis, while it is in the State of Illinois and on the opposite side of the river, has a relation to St. Louis commercially that is very important. The railroads all terminate there, and the business between St. Louis and East St. Louis, telephonic and otherwise, is very great. The exchange at East St. Louis consists of only fifty subscribers, and about ninety per cent. of the traffic of that exchange is with St. Louis. Ordinarily, in the Law system, the trunk line business is done over two receiving wires, one from Exchange A and Exchange B and the other from Exchange B and Exchange A, and we have that same arrangement between St. Louis and East St. Louis. However, the ordinary method is for the receiving operator to throw a telephone and transmitter into the sending call wire and give an order, expressed by numbers, to the receiving operator. In the case of East St. Louis, which is occupied by an open circuit call wire which runs to the operator at the Central Office at East St. Louis, that line is extended—it is not grounded at East St. Louis, but it is extended to the receiving operator at East St. Louis. Consequently the order for traffic at East St. Louis is heard by both operators—by the one at East St. Louis and also by the one at St. Louis. The direction of the traffic is indicated by numbers.

The numbering series at St. Louis commences at 100 and runs up to 5,000, while the numbering at East St. Louis is confined to the 5,000 series. When the subscriber at East St. Louis gives his order, of course the direction of the connection is expressed in the way given. That order is overheard by the operator at St. Louis, and without any word between them they select the lowest number idle trunk line and the connection is made without any word passing between them. If any of you can beat that on the trunk line service we would like to know it.

Mr. Seeley: I would like to state, Mr. Chairman, that we are using a call wire precisely as Mr. Durant describes, with the exception of the St. Louis circuit. The operator who could formerly handle only seven trunk wires is at the present time handling fifty trunk wires. Instead of sending and receiving trunk wires, he virtually becomes a switchman at No. 1 exchange, while the operators at No. 2 exchange are simply calling into her from the call wire. I presume the company is saving ten or twelve thousand dollars a year in salaries on the trunk line system alone.

Mr. Gifford: There was something said this morning in regard to this return wire. I think the experiments practiced by Mr. McCluer were with the Law system of exchange, were they not?

Mr. McCluer: They were, sir.

Mr. Gifford: What I wish to inquire, to bring it down to the practical application, is whether any one here has attempted to use this return ground wire—universal ground—in connection with the magneto system?

Mr. McCluer: There is no difference.

Mr. Durant: Mr. Seeley explained that this morning. He said they had tried it, and that the short and long wires interfered with each other.

Mr. Gifford: I did not catch that. I have been considering that thing. I am very glad the experiment has been tried, and that somebody else has been to the expense before we have. I did not understand fully that it worked as satisfactorily with the magneto system as with the Law system. One is a magneto and the other a battery current.

Mr. McCluer: It doesn't make a particle more difference than it does between the earth and any system. You use the earth for any system and you use this artificial earth in precisely the same way.

Mr. Gifford: There is another difference in the magneto system, the lines are grounded in your central office. I don't know but what that would make some difference.

Mr. McCleur: Not a particle.

The Chairman: Is there any further discussion on the switchboard?

Mr. Durant: What switchboard are you discussing:

The Chairman: I meant on the general principles of switchboard. We have three or four papers—the one that Mr. Sherwood read was in the direction of switchboards, and Mr. Selley's remarks also, and we have had before us the underground work in Brooklyn, and Mr. Beckwith's paper on the underground question. It seems to me that it would be well to apply the discussion to these subjects one after another, and therefore I will call for any remarks on my own paper on the underground work in Brooklyn and Mr. Beckwith's paper on the underground work in New York. If there are any remarks by any of the gentlemen on those subjects, I think now is the time to make them. Furthermore, I think the members should remain here, as in a very short time we will want to take up the question of where we shall meet next year. Members should wait to decide that important question, even if they do not take any interest in the subject under discussion.

Mr. Durant: I thought that was generally left to the Executive Committee.

The Chairman: As to the date only, I believe, Mr. Durant. The Association usually votes for the place; but on account of circumstances local to the place selected, the time is fixed by the Executive Committee.

If there is no discussion on these papers, I will ask the secretary to read the paper by Dr. Plush.

The secretary read the paper by Dr. Plush:

The Chairman: Gentlemen, you have just heard the paper contributed by Mr. Plush. What is your pleasure?

Mr. Seeley; I move you that the paper be spread upon the minutes of the Association, and a vote of thanks be extended to Dr. Plush.

The motion was carried.

The President: Are there any remarks on this paper?

Mr. Durant: Since you ask for remarks, Mr. Chairman, I will make this remark—that I do not believe there is a class of men in the world who appreciate the telephone less than the men engaged in the business. The reading of the paper called to mind a statement made to me by the manager of one of the largest and best papers in the country, published at St Louis. He told me that on the night of the earthquake—it occurred about 12 or 1 o'clock at night—that inside of two hours he called up 103 stations in various parts of the city, and got two columns of very interesting matter, showing the effect of the shock in various parts of the city. That will perhaps show its value in one direction.

The capacity of an operator under great stress was decided in our exchange, I think, last January, under the direction of Mr. Doolittle, and if any of you have not made that test, I would suggest to you to make it, to show the number of connections that can be made in a given time by a single operator. On this test 53 were made in five minutes.

A Member: How many do you suppose their operator could make in an hour?

Mr. Durant: I don't know; I suppose seven or eight hundred.

The Chairman: Are there any further remarks on the subject of the telephone? There is but one other paper to be read, and that is the statistical report of the secretary, which is usually printed instead of being read, so that we will take up some other matter. The application of the National

Conduit Manufacturing Company for associate membership in the Telephone Association has been approved by the Executive Committee, and now comes before the Association for their action. What is your pleasure, gentlemen, in regard to this application for associate membership?

Mr. Eastabrook: I move that the action of the Executive Committee be approved.

The motion was carried.

The Chairman: The next question before the meeting will be the place of meeting for next year, and that I believe it is customary for the Association to act on as a body, but the Executive Committee determined the date after the place is selected. In that connection the secretary will read two letters which he has here.

The secretary read the following letters:

New York, September 4, 1888.

Henry Metzger, Esq., President.

Dear Sir: In behalf of the Erie Telephone & Telegraph Company and the Northwestern Telephone Exchange Company, I take pleasure in renewing our invitation of last year, that the next session of the National Telephone Exchange Association shall be held at Minneapolis, Minn. With assurances that there shall be nothing lacking for the comfort and enjoyment of the delegates, I trust that this invitation will be unanimously accepted. Fraternally yours,

CHARLES J. GLIDDEN, *Treasurer.*

September 4, 1888.

The National Telephone Exchange Association, C. H. Barney, Esq., Secretary.

Dear Sir: On behalf of the Michigan Telephone Company a cordial invitation is extended to the Association to hold its next annual meeting at Detroit, Mich.

Very truly yours,

F. A. FORBES, *General Supt.*

Mr. Durant: I move that Detroit be fixed as the place of the next annual meeting.

The motion was seconded.

Mr. Metzger: I move that Minneapolis be selected as the place of the next annual meeting. I think it is certainly due to the Erie Company after the manly effort they made last year to secure Minneapolis as the place for our next meeting, that this Association should meet their views and their request. If we go to Minneapolis we certainly, most of us, will pass through Detroit, so that we will see Detroit, and if we go to Detroit only we will not be very apt to see Minneapolis.

Mr. Gifford: I believe that when this matter was discussed last year it was tacitly understood that if Minneapolis waived her claims for this year that we would meet at Minneapolis next year, and I think it is due to Minneapolis, as our worthy president says, that we should go there for our next meeting. After that I would like to go to Detroit, if they would invite us.

Mr. Bailey: In view of the very pressing invitation received from the gentleman from Minneapolis last year, I think it would be exceedingly discourteous not to accept this pressing invitation.

The Chairman: Are there any other suggestions, gentlemen, as to the place of meeting, if not, I presume we shall have to take a ballot.

Mr. Eastabrook: In order to save a ballot, unless Mr. Metzger is willing to make his proposition in that shape, I move Mr. Metzger's resolution as a substitute for Mr. Durant's. Probably Mr. Metzger will accept that.

Mr. Metzger: I will accept that suggestion and offer it as a substitute.

The Chairman: It is moved and seconded that Minneapolis be substituted for Detroit in Mr. Durant's resolution. All in favor of the substitution of Minneapolis for Detroit, will say aye.

The motion was carried.

The Chairman: That brings the question back to the original resolution which is to designate Minneapolis as the place of meeting for next year.

The motion that Minneapolis be selected as the place of meeting next year was carried.

The Chairman: I believe that fairly and finally and fully decided that Minneapolis shall be our place of meeting next year.

Mr. Glidden: I desire to thank the Convention for the acceptance of this invitation, and I will guarantee Mr. Durant a nice time if he will come to Minneapolis.

Mr. Durant: I have not the slightest doubt of it. I did not want to see Detroit slaughtered though.

The Chairman: There is one other paper to be read. It is entitled "An interesting judicial opinion as to the rights of a telephone company against house movers!" I do not know whether that is a very interesting subject to the members here present. The paper is not very long. Attached to it is the printed charge of the judge to the jury defining the law as to the rights of telephone companies with respect to house movers.

Mr. Durant: We have already received a printed copy of that opinion from somebody.

The Chairman: I think, then, if the Association agree to it, that this paper will be offered and printed as a part of the proceedings of this Association, to save the delay of reading. If that is your pleasure, gentlemen, it will be so ordered.

I believe that leaves nothing else but the statistical report of the Secretary which it is not usual to read. It is largely figures, some of which, however, are interesting. If the Secretary comes in, perhaps a portion of it had better be read. Pending that if there are any remarks upon the subject of the interesting papers we have had before us we will be glad to hear them.

Mr. Eckert: On behalf of the Metropolitan Telephone Company I desire to extend an invitation to the members and delegates to visit our new building and the big switchboard at any time during their stay. We shall take a great deal of pleasure in showing it to them.

The Chairman: Mr. Eckert, the General Manager of the Metropolitan Company, has just extended to you a cordial invitation to visit the new Metropolitan Building, No. 18 Cortlandt street, where he will be very happy to show you all the improvements that have been made in the telephone business in this city.

Pending the reading of the statistical report by the secretary the time might be profitably occupied by the discussion of any of the questions that have arisen in the papers that have been read before us. I shall be very happy to answer any questions in connection with the paper that I read.

Mr. Kerr: The question of taxation by the boroughs, by the cities, by the townships and by the State, has caused the Pennsylvania Telephone Company a good deal of trouble. I believe the law in Pennsylvania is in a mixed up condition, and it is probable that members of the Convention here could throw some light upon the subject which would assist us in determining what course we ought to pursue. The Pennsylvania law, I believe, as to the taxation authorized by boroughs, is that boroughs can only tax after the analogy of the taxation by the County Commissioners. The Act signed by the Governor of Pennsylvania on the 24th or the 25th of May, 1887, gave the cities of seven classes the right to tax telegraph, telephone, electric light and power companies; that is, to charge a license tax. There are, however, decisions by the Pennsylvania courts which show it perfectly distinct that the plant of a corporation cannot be taxed. Notable among these is the Coatesville Company's decision which is constantly cited by the Western Union and by other companies interested in the matter. It was there decided that plant was capital and could not be taxed. Now, almost every city and borough in which our company is interested is trained to tax and is trained to institute a poll tax. The Western Union Telegraph Company has recently secured a decision of the Supreme Court of the United States that a poll tax confirmed by the ruling of the Alabama Supreme Court is illegal. I believe that is on the principle that the line is an interstate line and business an interstate business.

However there is another principle raised on which the Western Union Telegraph Company are now standing, and that is, that the boroughs and cities have a right to tax and to charge this license tax only on a police principle, and this license tax cannot be a tax per poll, but must be a tax on the telegraph property in proportion to the value which the telegraph property bears to the other property taxed on the police principle in the city. This has reduced the Baltimore & Ohio Telegraph Company's tax in one city, I am told by Mr. J. B. Stewart, Superintendent of that company in Baltimore, to the sum of thirty-nine cents, whereas the effort to tax was something like a dollar a poll. Now, if any company represented here in the Convention can name any principle which governs other states or the law of other states, or which is established by the law of other states, which would form a precedent, as Pennsylvania law is undecided, it would be very useful. If any person, also, has seen any decision of the Supreme Court of the United States which is to the effect that the tax must be a tax on the police principle, and in proportion to the value that telephone or telegraph property bears to other city property, it would be very useful, because the establishment of such a principle by the Supreme Court of the United States would render it impossible for any city or borough to tax at so much per poll, and as the cities and boroughs are trained to tax at so much per poll, it would be a very important thing for telephone companies to know whether we could not, on some legal basis established by the Supreme Court of the United States, contest that effort of the boroughs.

The only other question I have to ask is, that if there be any such principle established by the Supreme Court of the United States, whether there be within the knowledge of gentlemen present any principle established by the Supreme Courts of other States which could form a precedent towards establishing the law in Pennsylvania. I take the liberty of asking you, Mr. Chairman, whether you will have the goodness to submit these questions to the room?

The Chairman: Gentlemen, you have heard Mr. Kerr's remarks in relation to taxation in the State of Pennsylvania. Are there any remarks?

Mr. Gifford: The matter has never been brought before the courts of the State of Kentucky. I suppose there are always some people in every Legislature, who, from motives of patriotism or some other ism, like to put a heavy tax on corporations. But we appeared before the Committee on Law and Taxation in the Kentucky Legislature and stated our case to them, and they decided to levy a State tax in this way: One-fourth of one per cent. upon our gross receipts in lieu of all other taxes. While that is a little more than the average rate that other people have to pay on their property, we deemed it policy to consent to it, and it is the law—one-fourth of one per cent. in lieu of all other taxation. In the State of Kentucky machinery in operation is not taxed, and our assessors have considered that our central office system, our bells, telephones and transmitters come under the head of machinery, and they are not taxed. I have been in the habit of going to the assessor and asking him what he thought the thing was worth provided the patent was removed. I would say, "What would you give for those wires and poles around here?" He would say so many thousand dollars, and he taxed it that way, and we paid as we would on any other personal property at that rate. We also have a very reasonable business license. We are perfectly satisfied with it. It is about two and a half times what the average license is. The city license in the city of Louisville is based upon one dollar upon a thousand. At that rate our tax would be $125 or $150. They have assessed a license tax of $250 a year. We thought it would not pay to quarrel with the municipal authorities for $125, and we acquiesced in that. We anticipate no trouble from the tax question there; but nothing of the kind has ever been brought before the courts.

Mr. Durant: I presumed that every possible question that could arise under the various laws authorizing taxation has been raised in the State of Missouri and passed upon, and as a rule all those things go to the Supreme Court. But I regret that I am not able to give the gentleman any of the information which he seeks. The situation of our corporation is this: We pay a tax upon our personal property the same as any other cities in the State. In addition to that, the city of St. Louis is authorized by its charter to impose a license tax upon sundry callings, and it was a question whether they had that right to impose it upon a telephone company. We concluded that it was very much better than a tax upon our poles, and when the matter was under consideration we concluded that we preferred that. The result was that we pay them an annual tax, paid semi-annually, upon our gross receipts—quite a considerable sum, and after 1890 it doubles.

Mr. Bailey: Do I understand the gentleman to say that he pays a tax on his gross receipts to the city government as well as the State?

Mr. Durant: No; we pay the tax on our gross receipts to the State. We pay the tax on our personal property—it would be to the county, but as a matter of fact the city of St. Louis is an independent locality by itself; it is not in any county. There is a county of St. Louis and a city of St. Louis, but they are independent organizations. The city of St. Louis used to be in the county of St. Louis, but by its special charter adopted some twelve years ago it is independent of the county. We pay the tax on personal property to the collector of taxes. We pay the tax on the gross receipts to the city treasury—that is, the gross receipts within the confines of St. Louis city.

Mr. Drake: There are very simple matters in vogue in Iowa and Nebraska of taxation.

In Nebraska, the companies report their property direct to the State Auditor. The statements are laid before the Board of Equalization. They assess the property and then assign to each county its proportion. The county authorities then collect the municipal and state taxes. In Iowa the State Board of Equalization fixes the assessments upon statements from the companies and levies the tax direct The tax is paid to the State Treasurer, and that is in lieu of all other taxes of every description. No other city or county authorities have any right to levy any tax on any telephone or telegraph property.

Mr. Durant: Are you quite sure that any city in Nebraska has a right to license.

Mr. Drake: In Nebraska they have a right to license—what they call an occupation tax; that is a special prerogative bestowed upon municipalities—a tax upon the business not upon the property.

Mr. Durant: Are those occupations specified in the charter of the city of Omaha?

Mr. Drake: Yes, sir.

Mr. Durant: And the telephone and telegraph companies are omitted from the list.

Mr. Drake: No, they are included in Nebraska. You, as an individual, may own a good piece of property on which you pay a special state and county tax. On that piece of property you are conducting a business. They will sell you a license to do a business in the town.

Mr. Durant: Why cannot they license you to do a telephone business in the city of Omaha?

Mr. Drake: They do not in the city of Omaha, but they do in many of the towns and cities.

Mr. Durant: Then that license tax is in addition to the personal property tax?

Mr. Drake: Yes.

Mr. Bailey: I would like for our president to give us some light on the tax question as to the States of Pennsylvania and Ohio.

Mr. Metzger: I must confess that I did not hear the subject of this confession; at least I did not hear what it was about; I was otherwise engaged. But it seems to me that the tax question is a political one, and I cannot see how or in what way this Association can affect the method or mode of taxation. In Pennsylvania, of course, we are taxed upon our gross receipts, and also upon the dividends. I think it is $\frac{8}{10}$ of one per cent. on our gross receipts and then three mills upon every one per cent. of our dividends based upon our capital stock. In the smaller towns of Pennsylvania we are not taxed for poles. In the city of Pittsburgh proper we are taxed for business purposes. That is all the tax that we pay for business purposes, and of course we are taxed at the same rate of taxation as all other classes of business based upon the amount of sales or receipts. But there is no tax on poles or wires or telephones. In the State of Ohio they tax us on the poles. There they have a property tax. The tax is on the value of the plant and they have sought of late years to tax us on the telephones, which we have resisted, and so far successfully, and we are taxed precisely the same as all other citizens are taxed, and we have been unable to find any reason to object to it. We do not know why we should object to it. We think that we are entitled to pay our taxes just the same as the citizen who owns a house and lot or, in fact, any other corporation.

In the State of Ohio we have no State tax. Of course we exist there by comity between the States, under the rule that a corporation chartered in one State may transact business in another State. We have another town in the western part of the State called Newcastle. A member of the Council there did not pay his bill, and we brought him up with a round turn and compelled him to pay his bill. In the tax ordinance he moved that the telephone companies pay $250 as a license tax. The electric light companies were taxed $125, the natural gas companies were taxed $125, and so on, depending upon the character of the business. We told the Council plainly that we would resist the payment of that tax; that they had no right to discriminate; that if they taxed us the same as they taxed all other companies on the same volume of business that we would pay; that we were not going to pay $250 when the natural gas companies, whose revenues were ten times greater than ours, paid only $125. What the result of that case will be I don't know, but I am inclined to believe that the Council will modify their action in that regard, and tax us the same as they taxed the other companies. At least, if they do not, we shall resist it by all legal means that we have at our command.

The Chairman: I take it that Mr. Kerr wanted to get information as to the valuation of telephone property as a basis for taxation as much as anything else. It might be interesting to get views of members from various parts of the country on that. In my experience I have had struggles with various assessors over their extravagant ideas of the value of poles and wires.

Mr. Gifford: If that is the subject I would say that we make our returns based on the original cost of the plant, and from that we deduct ten per cent. annually for depreciation, and we make that return under oath, because we believe that is a fair statement of the actual value of the plant.

Mr. Bailey: I would inquire if in making those returns the president includes his corporation appliances or merely what we might term personal property and buildings. There was a law in Pennsylvania that a corporation was free from local taxation, and was only subject to the general taxation law of the State. In Pennsylvania, I think, the great bulk of the entire State Government was carried on by taxation of corporations. Railroads and other corporations—gas companies and water companies have fought that all the way through and uniformly with success. About a year ago or a little further there was, as Mr. Kerr says, a law passed allowing cities to tax telephones and telephone companies at a certain rate. We have never made any resistance to what they attempted to do. The generality of cities have levied what they call a police tax—a police franchise, and rather than bring up the question we have paid it cheerfully. Some of the smaller towns have attempted the same thing. So far I have been able to throw them off the track by going and seeing

the council—generally the council's attorneys and arguing the question with them with the uniform results of having them withdraw all the claims. There is one case that I have in mind that by agreement between our attorneys was settled by a case stated; that is a question of law to be heard before a judge of the Court of Common Pleas; that has not come up yet.

Mr. Metzger: I would say in regard to Mr. Bailey's remark, that there was an Act passed in 1887, authorizing the creation of cities of the fourth, fifth, sixth and seventh class. That Act gave express authority to councils to levy a tax on telephone companies in the language of the Act. It is under that Act that these councils are acting. They do not fix any rate, however; they leave it optional with the city council as to what it shall be.

The Chairman: If there is no further discussion on the question of taxes, the time of adjournment is drawing very near, and I think we better take the statistics. The Secretary will run briefly through those, as the figures are tedious, and they will be printed.

The Secretary: As it lacks only 15 minutes to the time of adjourument, I am afraid I cannot get through, and if I did I am afraid no one else would be in the room to hear me. These figures, if read, are very difficult to follow, and as they will all be printed, if it is the pleasure of the Association, I would suggest that I have leave to report in print. If there is any special table that wants to be picked out and read, I can do that perhaps in a few minutes. Otherwise, I would suggest that it would be printed.

Mr. Drake: I move that that be the course adopted—that we read them after they are printed.

(The motion was carried.)

The Chairman: In that case the report will take the course which is the usual course at all the meetings.

The Secretary: I think it is necessary that the Executive Committee should be empowered to fix the time of the next meeting.

Mr. Drake: I offer that resolution, and would like to inquire if the Executive Committee have considered it advisable to call an Executive Session of this Assembly, as they were given power yesterday to do.

Mr. Metzger: There has been no action on the part of the Executive Committee. As we understood the action of the Association yesterday, it was decidedly averse to holding what might properly might be termed secret sessions, and hence it was not necessary to call the Association together as a committee of the whole. Mr. Tyler offered an amendment to the original resolution on that subject, and he was to present the amendment to-day, but the Association has not had the pleasure of having that amendment beforehand, so nothing more has been done.

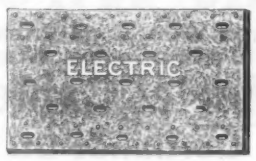
Mr. President, if there is no further business on hand I move we adjourn *sine die*.

The Chairman: Mr. Drake's motion is before the house, Mr. Metzger, the motion to empower the Executive Committee to select a date for our next annual meeting at Minneapolis.

Mr. Drake's motion was carried.

The Chairman: If there is no other business before the house I declare the meeting adjourned *sine die*.

Perforated Leather Belting.



The above cut illustrates a novel method of preventing "air cushions" in belts run at a high rate of speed.

The perforations are made in a regular and uniform manner and at equal distances apart, over the entire surface of the belt; thus insuring equal tension and leaving the tensile strength of the belt uninjured. Besides preventing "air cushions" these belts run smoother, steadier, and make less noise, than ordinary belts. They are adapted to high speed dynamos, especially those of the alternating current system.

Chas. A. Schieren & Co., of New York, have been granted a patent on this article, dated May 24th, 1888, and have just completed the machinery necessary for its manufacture.

It was reported that the telephone exchange fire in Dayton, Ohio, was caused by current from the Sprague Company's electric motor wire. As this company has no road in that city, it very properly desires the report corrected.

The Telephone.

BY DR. S. M. PLUSH, OF PHILADELPHIA, BEFORE THE TELEPHONE CONVENTION, SEPTEMBER 5TH.

No discovery or invention was ever born at a time when the world was more ready to receive it than that of the telephone; notwithstanding which, great talent, perseverance and wealth were necessary to its successful introduction. The uncertainty which unfortunately hedged about it gave rise to temporary work and machinery, which has simply been renewed to the present time, and, to-day, the vast telephone system of the country is but a network of unreliability and temporary makeshift. Even the head centers or main exchanges (with but few exceptions) representing untold labor and the expenditure of large sums of money in machinery apparatus are held by but a feeble tenure.

At that period but little time was given for consideration, and a forecast of what the future would be was difficult.

The growth of the telephone plants was without a parallel in any industry; the demands made upon them were greater than their means of supply; competent labor was not in the market, and efficient machinery had not been devised.

The difficulty of meeting the requirements of a large number of subscribers at a given point early presented itself, and gave rise to a number of small exchanges, even in the most populous districts. This, together with the resistance on the part of the public authorities to the erection of necessary conductors, set the seal of fixidity upon what is manifestly a great hindrance to good and reliable service, while in nowise conducing to economy. The expense for rents, light, fuel, trunk lines and the introduction of so many additional connections into circuits, call loudly for aggregation, and we believe the tendency is in this direction and the time not remote when trunk lines will be known only as a means of reaching points far distant.

Probably the greatest drawback to-day, to the complete development of our telephone systems, is a growing tendency in legislative bodies to regulate prices to be charged for service; which in effect is simply to paralyze its growth and efficiency.

Were the telephone the only means of communication, some regulation might be wise; such however is not the case—we have the postal, telegraph, and messenger service—each filling its own peculiar sphere, as regards reliability, speed and cheapness. The telephone should, so far as practicable, combine all of these features, but neither should be sacrificed to the others; to regulate either must be at the expense of the whole.

When the field is once open to competition, that company which rigidly adheres to reliability and promptness in its service will not suffer through paucity of its finances.

Nothing in my opinion has operated more to the disadvantage of both the telephone companies and their subscribers, than cheap rates. Many, through this means, have been induced to become subscribers to an exchange who have no real need for the facilities it affords. This lends a tone to their business, it is true, and serves in a measure as a card of respectability. Their place at once assumes an imaginary importance, and if there is any one thing that delights them more than another, it is, having some real or fancied business with a leading and substantial firm. This they manage to have at frequent intervals, thus taking the time and monopolizing the wires of others to their detriment and absolute loss. Important business is thus delayed, and the value of the exchange materially lessened.

Busy houses, to-day, find it necessary to have some one in constant attendance at the telephone, and yet, many calls are so delayed as to be useless. It is but fair therefore, that their interests should have as many safeguards thrown around them as possible; that their convenience and time may not be engrossed by frivolous questions, in which they have no interest whatever. In other words, an exchange may be so large as to be comparatively worthless.

Constant effort towards speed, both of connection and disconnection is being made; thus making a greater number of calls in a given time possible, and therefore removing the limit, which would otherwise soon be reached; but this limit must ultimately be reached, and what then? Even now requests for discrimination in making connections are not uncommon.

At the present growth of our larger exchanges, the time must come when a more select means of communication will be demanded by the business public. That is, an exchange for business (select, if we may so term it) where a party to become a subscriber, will not only be required to pay his annual rental for service, but, must hold a certificate of membership as well.

George Elliot remarks, that we begin life, knowing little and believing much; a few years of experience, however, and in many cases, the quantities are inverted. This aptly applies to every man connected with electrical science and mechanics, particularly the telephone and its environments.

We live to-day in the same atmosphere we did ten years ago; nothing has materially changed, except ourselves, and we only in credulity. True, our experience has been great and varied and has taught us in some instances, how not to do, and by this slow but certain method of evolution, may in time teach us how to do.

It is difficult for us to realize that we are gradually making a history and that the records of the great telephone must eventually be written; that we are each of us contributing thereto; that no matter how small a factor each may be, he is a part, and that at last, his individual size must be determined by the magnitude of the whole.

It behooves us therefore to see that the foundations of the telephone—which are now being laid—shall be solid and firm, that every right, every franchise, shall be permanent, every structure substantial, every centering point immovable and every method correct, and to this and the energies and intelligence of those associated with the telephone can be profitably directed.

The Telephone Exchange of New York City.

PAPER READ BY E. F. SHERWOOD, BEFORE THE TELEPHONE CONVENTION, SEPT. 5th.

The Metropolitan Telephone and Telegraph Company has 7,300 subscribers, operated by 11 exchanges which are furnished with the following systems: John, 39th and Harlem Exchanges, Western Electric Multiple; Pearl, New, Nassau, Murray and 21st Street Exchanges, use the Chinnock system: Spring Street, the improved Chinnock system, adapted by Mr. Jos. P. Davis, formerly general manager of the Company; Fulton and Beaver street exchanges use the Law system.

John street exchanges has 799 subscribers and 40 trunks, distributed among them. 39th Street Exchange has 1,108 subscribers and 39 trunks and Harlem has 374 subscribers but no trunks terminating outside of the trunk sections. The reason that we have trunks at the two former exchanges among the subscribers is to connect the system with points not accessible or convenient to reach with trunk calling wires.

To operate the boards during the busiest hours requires the following number of operators: John St. 14 operators, 57 subscribers per operator; 39th St., 21 operators, 52 subscribers per operator; Harlem, 6 operators, 62 subscribers per operator, but counting the trunk wires according to the business done over the average subscribers wire will be equal to adding 73 subscribers to John St., and 70 to 39th St., thus increasing the average at John to 62 and at 39th to 56. The reason we have a greater average at John and Harlem is that they are situated in the centre of business district, while 39th St., being a manufacturing and residence district a larger portion of the business is trunk.

We are using what we term trunk calling wires between the various exchanges, one terminating at John St. and the other at 39th St. for calling all trunk connections to the exchanges named.

There is an average of 3,000 connections per day called over each of these wires, and as each connection is ordered off again the number of orders is increased to 6,000. All of this work is done by two operators at each of these exchanges and could be done by one if a whole section of the board was within her reach. We divide the trunks, one-half being used for receiving and the other half for sending. Those we receive on are not multiple through the board, but end in cords and stand open at all times except when in use. When a number is called on any given trunk the connection is immediately made and is ready for ringing, this being done by the office calling, as we make the office where the call originates responsible for the connection. If the number called is busy we throw battery on the trunk dropping the annunciator as a signal. We find this system very advantageous as there is no delay in calling or clearing trunk connections and the service is made prompt as shown by ten trunk connections made and conversations started with subscribers in six and one-half minutes.

At the exchanges which have the Chinnock system each operator at the cases answers 100 subscribers and completes all local connections, using a local calling wire and a set of local trunks which connect all the cases together. The calls for trunk connection are written on slips of paper and passed to the operators who control the trunks to the various exchanges. Ten trunk connections were made and conversations started through this system in 12½ minutes.

The Fulton and Beaver street Exchanges have, together, 410 subscribers, and are operated by nine operators and one chief operator. All local connections are completed by the operator who receives the call over the calling wire and trunk connections are completed by the operator at the exchange for which the subscriber calls. The Law operator simply connects the subscribers' wire with the trunk wire, and rings down the annunciator. When the operator answers and ascertains from the subscriber the number wanted. The trunk connections made through the Law system were completed and conversations started in four and one-quarter minutes.

The number of trunk wires connecting the exchanges in New York City is 532 and average 60 connections per day and as this average could be increased to 70 per day, the number of subscribers could be increased 600 without increasing the trunk facilities. To other exchanges we have 187 trunks and with those the service is quite satisfactory and especially so with the new Brooklyn exchange of the New York and New Jersey Telephone Co., as the service is prompt and satisfactory in every particular.

By the consolidation of the seven exchanges in the new exchange at 18 Cortlandt street, 206 trunks which connect these exchanges will be abolished, and the number of trunks to all other exchanges may be reduced for the total number divided among the seven exchanges will not be required when they are all accessible to an operator in the new exchange.

The new switchboard at 18 Cortlandt street will soon be completed, and the consolidation of the seven exchanges made. It is wired for 5,100 subscribers and 900 trunk wires. The subscribers' operators will attend to 50 or 75 wires, according to the business done at different sections of the board. Trunk calling circuits to the other exchanges will be in operation, each receiving trunk operator attending to 50 wires. The local battery of each operator's outfit will be two cells of storage battery, one to be in use during the day and the other at night. The one in use during the day will be charged at night from the main storage battery and the night battery will be charged from a dynamo during the day. All wires will approach the exchange through the underground system, the underground cables terminating in the cellar. From there they will be carried to the distributing board in the exchange by 334 conductor cables.

The consolidation of the several exchanges will be beneficial in many respects. The service will be improved, the great volume of "sent" trunk business will be reduced from 20,000 to 8,000 connections, and the running expenses of the exchanges will be reduced about $2,700 per month.

1,527 miles of wires are now underground and 2,784 separate wires are altogether or in part so working, most of which give general satisfaction. The underground facilities are rapidly increasing, 18 miles of 102 conductor cable running from 18 Cortlandt street to various points are now completed, and will be used when the exchanges are consolidated. Eight and three-quarter miles of the same cable will soon be run for trunks from 18 Cortlandt street to the other exchanges, thereby making the trunk service from this exchange entirely underground and doing away with the delays and expense of crossed and broken trunks, and will do away with the danger of crosses with wires carrying a heavy current which proved so costly in connection with the burning of the 39th street exchange, on which a few remarks may be of interest.

On May 23d, the 39th street exchange was set on fire by a cross with a wire carrying a heavy current, and one and one-half sections of the board was burned out. The work of restoring the Western Electric Multiple Board after it has been burned and saturated with water, can only be appreciated by those who have had it to do. In order to straighten out the wires it was necessary to make 1,260,000 tests to splice 9,600 broken wires, to replace 16 cables which were destroyed from the switchboard to the cupola, and dry out the saturated portion of the board. The work of getting the lines in complete working order was delayed by the accumulation of line trouble while the trouble men were working in the exchange, but the switchboard and all the lines were in complete order two weeks from the date of the fire.

Electric Railways in Boston.

THE WEST END LAYING TRACK AND BUILDING CARS.

That Boston is to have street cars propelled by electricity as a motor seems to be assured. The West End Railway Co. has made no secret of its intention to make a trial, at least, of this new method of propulsion. It is well known that some time ago the company obtained from the Brookline selectmen permission to lay rails on Beacon street, from the Boston line to Chestnut Hill reservoir, and also on Harvard street, from its junction with Beacon street to the Brighton line. This permission carries with it leave to establish and maintain an overhead wire for electric propulsion. The rails are already laid on Beacon street, Brookline, for a portion of the distance granted.

ELECTRICAL PATENTS

(Copies of any Patents in the following List will be sent to any address on receipt of twenty-five cents.)

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING AUGUST 26, 1888.

388,836 Electric bell; Moses G. Crane, Newton, Mass.

388,837 Electric annunciator; Charles H. Crockett and Chancellor C. Allen, Boston, Mass.

388,859 Electrical cash and parcel carrier; Geo. F. Green, Kalamazoo, Mich., assignor of two-thirds to Oliver S. Kelley, Springfield, Ohio.

388,862 Submarine torpedo boat; Horace P. Griswold. Providence, R. I.

388,869 Electric signal; Henry T. Hill, Manchester, N. H.

388,876 Magnetic Annunciator.

388,877 Magneto electric machine; William Humans, Cambridge, Mass., assignor to the American Magnetic Electric Co.. Jersey City, N. J.

388,922 Telegraph exchange system; Robert J. Sheehy, New York, N. Y.

388,960 Manufacture of secondary battery plates; Julian O. Ellinger, New York. N. Y.

389,001 Switch mechanism for electric batteries; Charles E. Ongley, New York, N. Y.

389,010 Dynamo electric machines; Andrew L. Riker, New York, N. Y.

389,029 389,030 Regulator for dynamo electric machines; Addison G. Waterhouse, Hartford, Ct., assignor to the Waterhouse Electric and Manufacturing Co., same place.

389,062 Telegraphy; Patrick B. Delany, New York, N. Y.

389,080 Electro-magnetic bell; William Humans, Cambridge, Mass., assignor to the American Electric Co., Jersey City, N. J.

389,096 Automatic thermo electric cut-off for water service supply pipes. 389,098 389,099 Anti freezing device for water pipes; Edwin A. Newman, Washington, D. C., assignor to the Newman Anti-Freezing Water Pipe Co., Chicago, Ill.

389,122 Device for actuating street or station indicators; William A. Turner, San Francisco, Cal.

389,123 Shoal water indicator; Pedro Vigil and Juar N. Reouelas, Mexico, Mexico.

389,124 Apparatus for utilizing solar radiant energy. 389,125 Art of utilizing solar radiant energy; Edward Weston, Newark, N. J.

389,140 Galvanic battery; Asahel K. Eaton, Brooklyn, N. Y., assignor of one-third to Colin M. Thompson, same place.

389,142 Printing telegraph; Bradley A. Fiske, U. S. N., assignor to the Western Union Telegraph Company, New York, N. Y.

389,151 Electrical gas lighter and extinguisher; George S. Hogan. Olmstead, Ky.

389,184 Commutator for electric generators; Otto Zech, Detroit, Mich., assignor of one-half to Gustav A. Winemann. same place.

DYNAMOS FOR SALE.

THREE SMALL DYNAMOS IN PERFECT ORDER.

One 50 Watts 10 to 15 Amperes Capacity.
" 120 " 4½ to 5 " "
" 125 " 4 to 5 " or
250 " 3½ to 4 " Capacity.

Ready for delivery at reasonable prices.

THOMAS PRAY, Jr.,
P. O. Box 2728,
Boston, Mass.

WANTED.

Six First-Class Inside Wiremen.

FOR PARTICULARS APPLY TO

THE PATERSON ELECTRIC LIGHT CO.,

207 MAIN ST., PATERSON, N. J.

THE BEST RECOMMENDATIONS REQUIRED.

WANTED.—First-class engineer. Practical and theoretical, and had electric light experience. Must be young and willing to work. Splendid chance for A No. 1 man with references

"ENGINEERING,"
Electrical Review Office.

WILLIAM A. DOTY,
MANUFACTURER OF
Electrical Appliances,
BELLS,
And Gas Lighting Apparatus.
THE LAW BATTERY.
727 FILBERT STREET,
PHILADELPHIA.

WANTED.—Travelling Agent, to the right party a permanent salary, for our "ALUMINUM," the new metal of wonderful alloying qualities for softening iron, steel, copper, &c. Enormous strength. Sample bar of Pure Aluminum by mail. Catalogue of new foundry cupula for process,etc.,free.
THE HARTSFELD FURNACE CO. (Ltd.)
CINCINNATI, O.

THE TRENTON ENGINE.
AUTOMATIC CUT-OFF,
BALANCE VALVE,
POSITIVE EXHAUST.
ECONOMY, DURABILITY AND CLOSE REGULATION GUARANTEED.
PHONIX IRON CO., Trenton, N. J., B'ldrs.
F. Van Winkle, 91 Liberty St. N.Y. Agent.

O. K.

Full Size!!!
NO ONE
Denies this to be the only safe automatic in the
LAND
Perfected
Improvements
Commend it to the Trade.
$6.00 EACH.
Discount (—).
A. L. BOGART,
22 Union Sq., N. Y.

A. H. MACKINNON,
BROKER, AUCTIONEER & VALUER,
ELECTRICAL PLANT AND APPARATUS,
(BOTH NEW AND SECOND-HAND,)
BOUGHT, SOLD OR EXCHANGED,
63 BROADWAY, NEW YORK.
250 CELLS JULIEN STORAGE BATTERY, 4 EDISON DYNAMOS, ETC.
Send for List "Electrical Bargains."

"Star" Foot Lathe Swings 9x25 in. LATHE Screw Cutting Automatic Cross Feed, etc.
Scroll Saws, Circular Saws, Lathes Mortisers. LATHE Catalogue Free of all our Machinery
SENECA FALLS MFG. CO. 688 WATER ST., SENECA FALLS, N. Y.

Charles R. Vincent & Co.
15 Cortlandt St., New York,
Ball High Speed Automatic Cut-Off Engines
Perfection of Regulation, Economical, Compact.
WAINWRIGHT COPPER CORRUGATED TUBE FEED WATER HEATERS,
Steam Boilers of Steel or Iron.

Detroit Electrical Works
MANUFACTURERS OF
ELECTRIC SUPPLIES,
INCLUDING
Medical Batteries, Skeleton and Box Bells, Burglar Alarms, House Annunciators, Fire Alarm Boxes, Pins and Brackets.
Insulated Magnet, Telephone and Electric Light Wire.
GENERAL OFFICES and FACTORY:
DETROIT, MICH.

FRESH TESTIMONIALS TO THE SUPERIORITY OF
SIMPLEX WIRE.

THE VIRGINIA ELECTRIC LIGHT & POWER COMPANY, OF RICHMOND, VA.
NEW YORK OFFICE, 63 WALL STREET.
New York, August 21st, 1888.

A. F. MASON, Esq.,
SIMPLEX ELECTRICAL CO.,
Boston, Mass.

Dear Sir:
I have been using the Simplex Wire on a large portion of our lines in Richmond, Va., for the past five months. I have taken daily tests of the insulation during that time. The longest single circuit I have is about five miles, and at no time has the insulation test ever been less than one megohm. I cannot speak too highly of the wire or its insulation. A large portion of it has been run through foliage and trees in the streets, and upon examination a few days ago I failed to find any place where the wire has been abraded by coming into contract with the branches of trees. My instrument does not measure over one meghom, and I cannot tell how much higher the insulation may have measured. One megohm on wires in circuit is euough for me.

Yours very truly,
W. H. COLE, *Superintendent.*

THOMSON-HOUSTON ELECTRIC CO.,
AUGUSTA, GA.
August 12th, 1888.

Dr. A. F. MASON,
SIMPLEX ELECTRICAL COMPANY,
328 Washington St., Boston, Mass.

Dear Sir:
We are using in our arc-lighting circuits about twerty (20) miles of your Simplex T. Z. R. wire.
We have feund the insulation a most perfect protection against moisture and the abrasion of small tree limbs.
Have used your wire in our station, for running through trees, on buildings and porches, under mouldings, etc., and through cellars, and we have never been able to discover a "ground" upon any circuit since our plant was put into operation.

Very truly yours,
JOHN H. WATERMAN.

ADDRESS,
The Simplex Electrical Co.,
328 WASHINGTON STREET, BOSTON, MASS.

EUGENE F. PHILLIPS, PRESIDENT. W. H. SAWYER, SEC'Y AND ELECTRICIAN.
American Electrical Works

PROVIDENCE, R. I.
MANUFACTURERS OF PATENT FINISHED
INSULATED ELECTRIC WIRES,
TELEPHONE & INCANDESCENT CORDS.
Electric Light Wire
Magnet Wire, Patent Rubber-Covered Wire, Lead-Encased Wire, Flexible Cordage, Office and Annunciator Wire.
Underground and Aeriel Cables.
New York Office: 18 Cortlandt St.
P. C. ACKERMAN, Agent.

SCHAEFER ELECTRIC MFG. CO.
INCANDESCENT LAMPS, From 10 to 100 Candle Power.
DYNAMO MACHINES of Improved Construction.
Proposals and Estimates furnished for Complete Installations of Incandescent plants upon application to
P. O. BOX 3068, Boston, Mass.
FACTORY AT CAMBRIDGEPORT, MASS.

PATENT "K.K." LINE WIRE
For ELECTRIC LIGHTING.
Telegraph and Telephone,
MANUFACTURED BY
HOLMES, BOOTH & HAYDENS,
TRADE MARK "K.K."
J. L. BARCLAY, Selling Agent, 185 DEARBORN ST., CHICAGO, ILL.
25 PARK PLACE, NEW YORK.
TRADE MARK "K.K."
THOMAS I. SCOVILL, NEW YORK AGENT.